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FOREWORD

Under the guiding hand of its beloved leader and first president, the late David Starr Jordan, Stanford University, from the date of its founding, assumed leadership in ichthyological research and training. Its graduates have taken an increasingly important part in taxonomic research on fishes, in the investigation of our national fisheries resources, and in the formulation and administration of national and international fisheries regulations.

In the past, the greater part of the results of ichthyological work done at Stanford has appeared in widely scattered scientific journals, since no ready means of local publication was available. Present conditions make it desirable to attempt some more uniform method of publication, and to provide an outlet for papers of a type that is becoming more and more difficult to place in the regular journals, because of the necessity of extensive illustration or of the comprehensive nature of the contents. The present Bulletin is therefore issued as a vehicle for the publication of the results of ichthyological research originating in, or connected with, the Natural History Museum of Stanford University.

In content, it is expected that the Bulletin will be largely taxonomic or morphological, but it is intended that papers dealing with fisheries biology shall be published, and the widest latitude in subject matter having to do with fishes will be allowed. However, certain definite standards and limitations have, of necessity, been set up, due primarily to smallness of available funds. In taxonomy, the chief need of the present day is the clarification of relationships and the integration of previous work. For this reason, the editor feels that carefully done systematic revisions, phylogenetic studies, and attempts to correlate scattered work on classification should be given precedence over mere lists or reports on collections. Descriptions of new forms are important, and will be included, since each discovery provides an integral part of our picture of phylogeny, but such descriptions will in all cases be accompanied by adequate discussions of relationships, and wherever possible, by partial or complete revisions of related species or genera. In morphological, physiological, ecological, or other studies, papers contributing to the great central problems of the evolution, adaptation, and dispersal of fishes will receive first consideration, while in zoogeography faunal lists will give way to adequate discussions of the relationships and history of faunas.

The printing of a scientific journal in a way other than by means of movable type deserves comment, particularly when the journal contains taxonomic material. The rule of priority, as fixed by the various International Congresses of Zoology in the International Rules of Zoological Nomenclature, has forced the serious consideration of what constitutes publication in the taxonomic sense. Practically all competent persons who have wrestled with the problem have conceded that publication means the printing, in permanent form, of the results of research and the making of this printed record available to interested persons. So far as actual value to zoologists is concerned (and this, after all, is the prime matter to be considered), this involves (1) the production of a large number of identical, relatively permanent copies of a paper; and (2) the making available of these copies to any person interested, through general distribution or public sale, or both, on a stated date. It has also been generally conceded that such ephemeral methods of reproduction as ordinary mimeographing do not constitute taxonomic publication, and some would even go so far as to rule that reproduction by any other method than movable hand-type or linotype be excluded from consideration.

There is no doubt that some standards of publication must be adopted and it is evident that definition of them will be difficult. But it is also evident that, rules or no rules, printing will continue to change with the discovery of new methods, and that the taxonomist will have to accept them. We cannot expect the linotype machine to survive indefinitely, any more than the hand-press did. Photolithography, by which the present journal is reproduced, fulfills every reasonable requirement of permanence, and the paper used has been especially selected for long life. Distribution on the printed date of issue will be wide, and copies will at the same time be placed on public sale. Every fundamental requirement of taxonomic publication has been met and no question should arise in regard to the published nature of the contents.

The Bulletin will appear irregularly, as material comes to hand. Volumes will be closed and indices provided when a sufficient number of pages has appeared.

The Bulletin is offered in exchange for any scientific journal or serial containing material of ichthyological or fisheries interest. Inquiries, and publications sent in exchange for the Bulletin, should be addressed impersonally as follows (*and in no other way*): EDITOR, STANFORD ICHTHYOLOGICAL BULLETIN, STANFORD UNIVERSITY, CALIFORNIA, U.S.A.

GEORGE S. MYERS, Editor.

WEST INDIAN CLUPEID FISHES OF THE GENUS *HARENGULA*

with Notes on *H. thrissina* from the Pacific Coast

by

MARGARET STOREY

The West Indian herrings of the genus *Harengula* have been the cause of much confusion in the minds of interested researchers. Study and comparison have been hampered to some extent by a lack of material, and proportions which serve as valid taxonomic characters in other genera prove worthless or misleading when applied to specimens of this genus. The fishes all look much alike. Furthermore, there is evidence of considerable variation within the species. Also, factors such as size, condition, preservative, and length of time in preservation may affect conclusions, especially when the worker has at his disposal but a few specimens from a single locality. Finally, the original literature is often difficult to obtain, obscure references are easily overlooked, few of the descriptions are adequate, and some of the types have disappeared. It is not surprising, therefore, that the number of species of *Harengula* in West Indian waters varies with the authority from one to six, that species from allied genera are sometimes included, and that there is little agreement on the generic name.

Reviewing briefly some of the most recent authors:

Regan (1917b), the latest monographer of the genus as a whole, recognizes three species of West Indian and one of Pacific Coast *Harengula: H. maculosa* Cuvier and Valenciennes, *H. macrophthalma* (Ranzani), *H. pensacolae* Goode and Bean, and the Pacific Coast *H. thrissina* (Jordan and Gilbert). He places *Alosa apicalis* Müller and Troschel, *Harengula jaguana* Poey, *Clupea macrophthalma* Günther, *Sardinella sardina*, and *S. macrophthalmus* both of Jordan and Evermann in synonymy with *Harengula maculosa; H. latulus, H. clupeola, H. humeralis*, and *Alosa striata* all of Cuvier and Valenciennes, *A. bishopi* Müller and Troschel, *Harengula sardina* Poey, *Clupea humeralis (partim)* Günther, and *Sardinella humeralis (partim)* Jordan and Evermann in synonymy with *Harengula macrophthalma;* and *Clupea humeralis (partim)* Günther, *Sardinella humeralis (partim)* and figure 193 of *S. sardina* both of Jordan and Evermann in synonymy with *Harengula pensacolae.* Regan had "several examples" of *H. maculosa* for study, "90 to 200 mm. in total length, from Florida, the Bermudas, and the West Indies"; "numerous examples, 80 to 130 mm. in total length, from Florida, the West Indies, Fernando Noronha, and Bahia" of *H. macrophthalma*; and "four specimens, 80 to 140 mm. in total length, from Florida and Trinidad" of *H. pensacolae. H. thrissina* was described from "a single specimen, 115 mm. in total length, from Jalisco."

Whereupon, Jordan (1918) notes that the "so-called 'scaled sardines' of the Atlantic Coast belong to a...genus *Harengula* (erroneously united with *Sardinella* by Jordan and Evermann). The valid species of this genus on the Atlantic Coast are apparently three, *Sardinella maculosa, macrophthalma* and *pensacolae.*"

But Meek and Hildebrand (1923), apparently without knowledge of Regan's revision or of Jordan's note, recognize but two Atlantic (*Sardinella sardina* and *S. macrophthalmus*) and one Pacific Coast species (*S. thrissina*). They include *Clupea macrophthalma, Harengula maculosa, H. humeralis, H. pensacolae*, and *H. arcuata* Jordan (1890) in the synonymy of *Sardinella macrophthalmus*, which they describe from "over 300 specimens ranging from 40 to 135 mm. in total length"

from Panama; "besides these we have examined specimens (variously labelled *macrophthalmus, humeralis,* or *pensacolae*) from Florida, Texas, Bermuda, Porto Rico, San Domingo, and Puerto Morelos. While there is considerable variation among individuals, especially with respect to depth of body, we find no constant differences." *Sardinella sardina,* with *Harengula sardina* and *H. callolepis* Goode included in the synonymy, is described from "several specimens from Cuba and Cozumel." Their description of *Sardinella thrissina* is based on 13 specimens "75 to 90 mm. in length," from Taboga Island, and they had for comparison the types and several small specimens. They distinguish *S. thrissina* from *S. macrophthalmus* only by a difference in the scales: "In *S. thrissina* all of the scales have crenate edges, but there are no evident striations on the body of the scales. In *S. macrophthalmus* only the scales on the back have notably crenate edges, and the body of the scales bears evident striations."

Breder (1927, 1934) follows Meek and Hildebrand for specimens from the Bahamas, Isle of Pines, and Glover Reef, and in his Field Book (1929).

Beebe and Tee-Van (1928) follow Meek and Hildebrand, with 82 specimens of *Sardinella sardina* and 10 of *S. macrophthalmus* from Port-au-Prince Bay, Haiti; but later (1933) they synonymize *S. macrophthalmus* Bean and *Harengula maculosa* (not of C.&V.) Regan with *H. macrophthalmus,* and note that they "prefer the treatment accorded to the genus *Harengula* by American authors as opposed to Regan's revision of the group. Accordingly we retain *sardina* as a valid species, and the Bermuda specimen assigned to *maculosa* by Regan is placed under *macrophthalmus."* Beebe and Hollister (1935) list *H. macrophthalmus* from the Grenadines, but Hollister (1936), in her first paper on the caudal skeleton of Bermuda fishes, observes: "These fish have at various times been called *H. macrophthalmus* or *H. sardina,* and their proper specific determination is a problem for future study," and therefore gives no specific name to the material examined.

Nichols (1929) records *Harengula sardina* from Porto Rico, and *H. macrophthalma* from Porto Rico and the Virgin Islands. He synonymizes *Sardinella sardina* Nichols (1915) and *S. sardina* Meek and Hildebrand with *Harengula sardina; Sardinella macrophthalma, S. humeralis* both of Evermann and Marsh, *S. macrophthalmus* Meek and Hildebrand, and *Harengula pensacolae* with *H. macrophthalma.*

Parr (1930) lists specimens of *Sardinella sardina* and *S. macrophthalmus* from the Bahamas and Turks Island, but, concerning the latter species, remarks: "While provisionally accepting the synonymy of this species suggested by Meek and Hildebrand...the author is inclined to believe that some of the forms now synonymized with *S. macrophthalmus* might quite probably become re-established as separate species by an adequate biometric investigation..."

From Brazil, Von Ihering (1930) complains bitterly at the "confusão de nomenclatura," but places *S. macrophthalma* and *S. sardina* both of Jordan and Evermann in synonymy with *S. (Harengula) maculosa,* with the expressed doubt that this species occurs in Brazil. It is significant that only *S. humeralis* Jordan and Evermann (described by them as a deep-bodied fish) is placed in the synonymy of *S. (Harengula) macrophthalma* Ranzani.

Longley (1932), after a study of material at Dry Tortugas and in various museums, gives the following: "*Harengula sardina* Poey = *H. maculosa* C&V = *H. clupeola* C&V = *?H. macrophthalma* (Ranzani). *H. pensacolae* Goode and Bean = *H. humeralis* C&V."

Hubbs (1936) studied six specimens of *Harengula pensacolae* from Yucatan, and noted high gill-raker and ventral scute counts, contrasting the former with the lower counts in *H. macrophthalma.* He points out that both differ from

H. maculosa, H. pensacolae particularly, and suggests that further study may prove the latter "to be only a subspecies of *macrophthalma* occupying the mainland shores of the Gulf of Mexico, leaving the West Indies to typical *macrophthalma*."

The present study was initiated with the hope that a fair amount of material from many localities, carefully subjected to old and new methods of treatment, and compared wherever possible with original descriptions, plates, and the types, might yield satisfactory results. Since the series are largely from museum collections, they cannot be considered random samples in the strictest sense, especially as to size. A great deal of possibly useful information is lacking. Nevertheless, the quantity and variety of the material seems adequate to provide descriptions which not only take into account natural variations within each species, as well as those resulting from differences in preservation, but also serve to distinguish from each other four West Indian species: *Harengula humeralis* (Cuvier), *H. clupeola* (Cuvier), *H. majorina*, sp. nov., and *H. pensacolae* Goode and Bean. The specimens at hand of *H. thrissina* (Jordan and Gilbert) from the Pacific Coast of North America have been studied, and the results herein recorded; but the conclusions offered for this species are of necessity only tentative, because of totally inadequate material.

The advice and suggestions of Dr. George S. Myers, of Stanford University, for the paper as a whole, and of Dr. Willis H. Rich, also of Stanford, especially for the statistical treatment of the data, have been invaluable, and far beyond thanks.

Prof. Jacques Pellegrin and Dr. Paul Chabanaud of the Muséum National d'Histoire Naturelle in Paris have, with unparalleled courtesy, sent the Stanford Natural History Museum a cotype of *Harengula latulus* Cuvier and Valenciennes, the genotype by original designation. Also, Dr. Chabanaud, Dr. Leonard P. Schultz of the U.S. National Museum at Washington, and Dr. William C. Schroeder of the Museum of Comparative Zoology of Harvard University at Cambridge have patiently searched out and carefully reexamined for me the types in their possession. Dr. Samuel F. Hildebrand of the U.S. Bureau of Fisheries at Washington has consulted Dr. Longley's notes and transmitted to me data from the latter's reexamination of the type of *Clupea macrophthalma* at Bologna. Prof. Alessandro Ghigi of the Istituto Zoologico della R. Universitá at Bologna most kindly had made for me the splendid photograph of that type, reproduced in this paper. Dr. E. W. Gudger of the American Museum of Natural History in New York had made a photostat of the description "De Latulo" from Schonevelde's *Ichthyologia* in the possession of that museum. To these eminent, busy men the author gives grateful thanks for their important contributions. Through the Stanford University Library and the good offices of Mr. Elmer Higgins of the U.S. Bureau of Fisheries an extended loan was made possible of the three volumes of Duhamel's *Traité Général des Pêsches* from the Library of that Bureau in Washington. Miss G. Shirk of the International Fisheries Commission at the University of Washington in Seattle not only placed at my disposal the facilities of the Commission's Library, but loaned me their volume three of Krøyer's *Danmarks Fiske*.

The unusually fine X-ray photographs are by Dorothy Starks, M.D., and the drawings of Clupeid scales were made by Pablo Bravo from specimens, and from photographs by Don C. Hines, M.D. Kenneth Stanton deserves great credit for his photographs of notoriously difficult subjects, museum-worn Clupeids.

Through the courtesy of Dr. F. M. MacFarland and Mr. H. Walton Clark, all the Clupeidae in the collection of the California Academy of Sciences in San Francisco were made available for this study. Many were from the original Indiana

University Collection. Prof. A. E. Parr and Mr. Martin Burkenroad of the Bingham Oceanographic Foundation of Yale University at New Haven made generous loans from their collection. The Stanford Natural History Museum provided numerous specimens collected during the last 70 years, many by Dr. Jordan. Clupeids were secured at Sanibel Island, Florida, in the Gulf of Mexico, by the author in 1935 and by Dr. Louise M. Perry, Dr. Margaret W. Lawrence, and Mr. George Underhill in 1937. Over 2,000 specimens, mostly of *H. pensacolae* from Yucatan and Florida, were sent me by Dr. Carl L. Hubbs of the University of Michigan at Ann Arbor, primarily for use in a detailed study of that species. A number of these specimens were studied and used to check my description.

DEFINITIONS OF MEASUREMENTS, PROPORTIONS, AND COUNTS

The measurements, proportions, and counts used include those usually employed, as well as a few that have seldom been used. Misunderstanding always arises when authors do not define the exact method of taking measurements; therefore, the procedure employed for this study is here outlined.

All measurements were taken with calipers from point to point as indicated, and all lateral measurements and counts were made on the right side unless that side was damaged. Broken caudal fins made total length data useless.

The TOTAL LENGTH is measured from the tip of the snout, not including the lower jaw, to the tip of the upper caudal lobe; STANDARD LENGTH is the distance between the snout-tip and the median posterior margin of the hypural fan. The DEPTH is the greatest vertical body depth, exclusive of fins. In this genus it is a line dropped to the ventral margin from the origin of the first dorsal ray. The HEAD LENGTH (referred to as "head") is measured from snout-tip to the hindermost point of the gill-cover, including the membranous flap. This is not necessarily a horizontal line. The SNOUT LENGTH (referred to as "snout") is the distance from the snout-tip to the inside edge of the anterior rim of the bony orbit. The EYE DIAMETER (referred to as "eye") is the greatest horizontal diameter of the bony orbit, inside measurement. Since eye diameter and EYE DEPTH have proved substantially the same in this genus, the former serves for the latter also. PREOPERCLE TO EYE is the vertical from the lower inside rim of the orbit to the lower edge of the preopercular bone, not including the interopercle below it. The use of the bony orbit as a point of reference excludes the factors of shrinkage or distortion of the eye. The DEPTH OF THE OPERCULAR BONE (referred to as "opercle") is the distance between the point where it joins the body dorsally and its ventral edge, including its membrane which overlaps the subopercular bone. The GILL-COVER DEPTH includes the opercular and subopercular bones and the membranous flap of the latter. HEAD DEPTH AT EYE is the total vertical head measurement through the center of the eye.

DEPTH AT OCCIPUT is the vertical depth, measured from the hinder end of the superficial bones of the cranium to the ventral edge of the body. The latter point is usually between the first and third ventral scutes. The BODY ANGLE measurements are best taken from fresh specimens, as distortions in shape become set in preservative. These measurements prove valuable for both large and small series. Each fish is laid on paper, right side uppermost. Marks are made on the paper with a sharp pencil directly below the following points: (1) dorsum at origin of dorsal fin; (2) ventral edge at the point directly below the last;

(3) upper anterior margin of upper lip; (4) anteriormost point of curve of lower jaw, with mouth firmly closed; (5) origin of anal fin; (6) point directly above the latter, on dorsum; (7) ventral edge of caudal peduncle just posterior to last anal ray; (8) dorsal edge of peduncle, at the point of greatest concavity in the dorsal outline. Lines, extending well beyond these points, are drawn with a ruler through 1 and 3, 2 and 4, 5 and 7, 6 and 8. The resulting four "body angles" may be measured in degrees with a protractor. For the present study, the ANTERIOR, POSTERIOR, and VENTRAL BODY ANGLES were measured to the nearest whole degree. The body angles of all specimens, regardless of distortions, have been included in the calculations. However, an effort was made to straighten out warped specimens.

The gill-raker at the angle of the first arch, if present, and all rakers below the angle of the first arch are included in the GILL-RAKER COUNT. To count the small but developed anterior rakers, it is sometimes necessary to slit the branchiostegal membrane, and even to separate the arch from its anterior support. The VENTRAL SCUTE COUNT is made from the anteriormost to, but not including, the scute which overlaps a vertical line from the point of origin of the ventral fin; and from that scute to the last before the anus, inclusive; and the total number of scutes. These counts, for example, are quoted as: 14 + 16 = 30. In the statistical work, only the total number of scutes was used, quoted as 30. The LONGITUDINAL SCALE COUNT is taken from the row below the dorsal angle of the gill-opening, from the gill-cover to the median posterior margin of the hypural fan. The TRANSVERSE SCALE COUNT is made caudo-ventrally from the origin of the dorsal fin. Since the topmost row of scales lies across the dorsal ridge, that row is counted as one-half row. The positions of the fins vary somewhat with the species, but hardly enough to make good characters. All DORSAL and ANAL FIN-RAYS that appear on the exterior of the fish are counted, without regard to the structure of their basal elements. The first three dorsal and the first two anal rays are small and are not well separated in these species, but are visible under manipulation. The last two visible anal rays are usually slightly thickened.

VARIABLE FACTORS. Though museum specimens are hardly reliable cross-sections of populations, especially in regard to length, it would seem from table 1 that *Harengula humeralis* and *H. majorina* are the largest species, and *H. pensacolae* the smallest.

In this genus, small specimens tend to have the same depth-in-length proportion, regardless of species, as shown in the graph (fig. 1) and the series (fig. 2). Since this tendency holds for certain other proportions as well, an arbitrary minimum length was chosen for each species, excluding the smallest fishes from final calculations. These minimums, and the average standard length for each species, calculated for the fishes above these minimums only, are shown in table 1. The minimum used, and the average here given for *H. majorina* are doubtless too low, due to a lack of material.

Table 1. Standard lengths of the specimens studied of West Indian *Harengula*.

Species	Minimum	Minimum used	Average used	Maximum
H. humeralis	46.6 mm.	71.0 mm.	102.4 mm.	141.0 mm.
H. majorina	51.7 "	61.3 "	100.1 "	144.5 "
H. clupeola	42.3 "	67.5 "	88.6 "	118.0 "
H. pensacolae	25.9 "	64.7 "	79.8 "	115.2 "

As may be seen in figure 1, even with the small sizes eliminated, there is still an appreciable and fairly constant variation in the depth-in-length proportion with the change in size, as shown by the trend lines. Since this is true for other proportions and the body angles, it accounts in part for the overlapping between the species in the graphic presentation of these characters (fig. 7).

The specimens have been preserved in different ways, and from a few weeks to 70 years have elapsed since their capture (over 100 years for the specimen of *H. latulus*). No data have come to light for fishes of this genus of the effect upon measurements of the length of time in preservative, but unquestionably this may be a factor of some importance, especially during the first two or three years of preservation. As to types of preservative, the Bingham fishes were fixed and have been permanently preserved in formaldehyde solution; the Sanibel and some of the Stanford fishes had their initial preservation in formaldehyde, and were later placed in alcohol. Most of the others have been in alcohol only. Of all the specimens studied, approximately 20% have been or are now in formaldehyde, the balance have always been in alcohol.

Lack of fresh specimens for controls, and of sufficient material in the various preservatives from a single locality, make it impossible at this time to more than suggest the degree of variation caused by the method of preservation, or by the length of time in a given preservative. However, the circled symbols in the graph (fig. 1) demonstrate that in the depth-in-length proportion, regardless of other factors, such as locality, species, length of time in preservative,

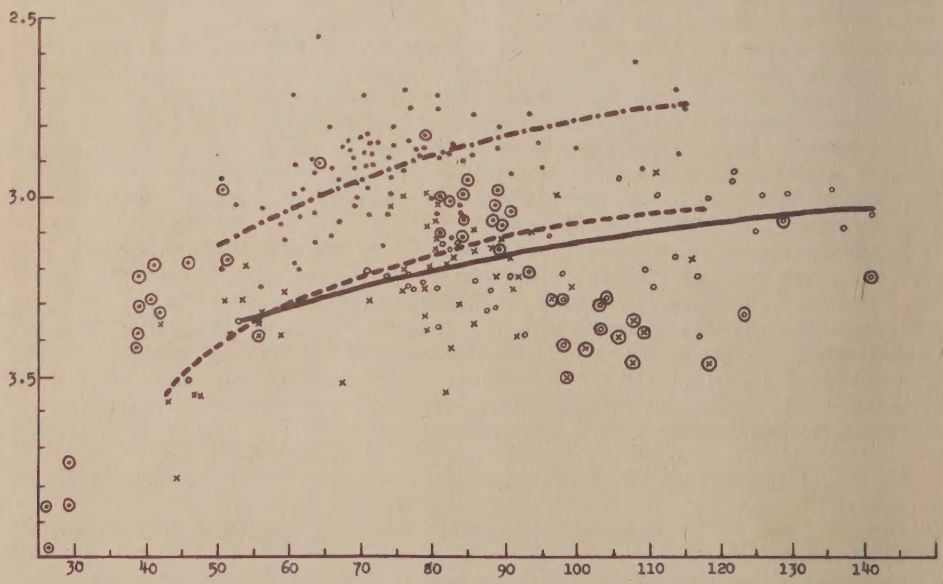


Fig. 1. Correlation diagram showing relationship of depth/length in *Harengula humeralis* (o,——); *H. clupeola* (+,----); and *H. pensacolae* (·,-·-·-·). Symbols in circles represent data for specimens fixed in formaldehyde. Lines show trends, fitted "by eye."

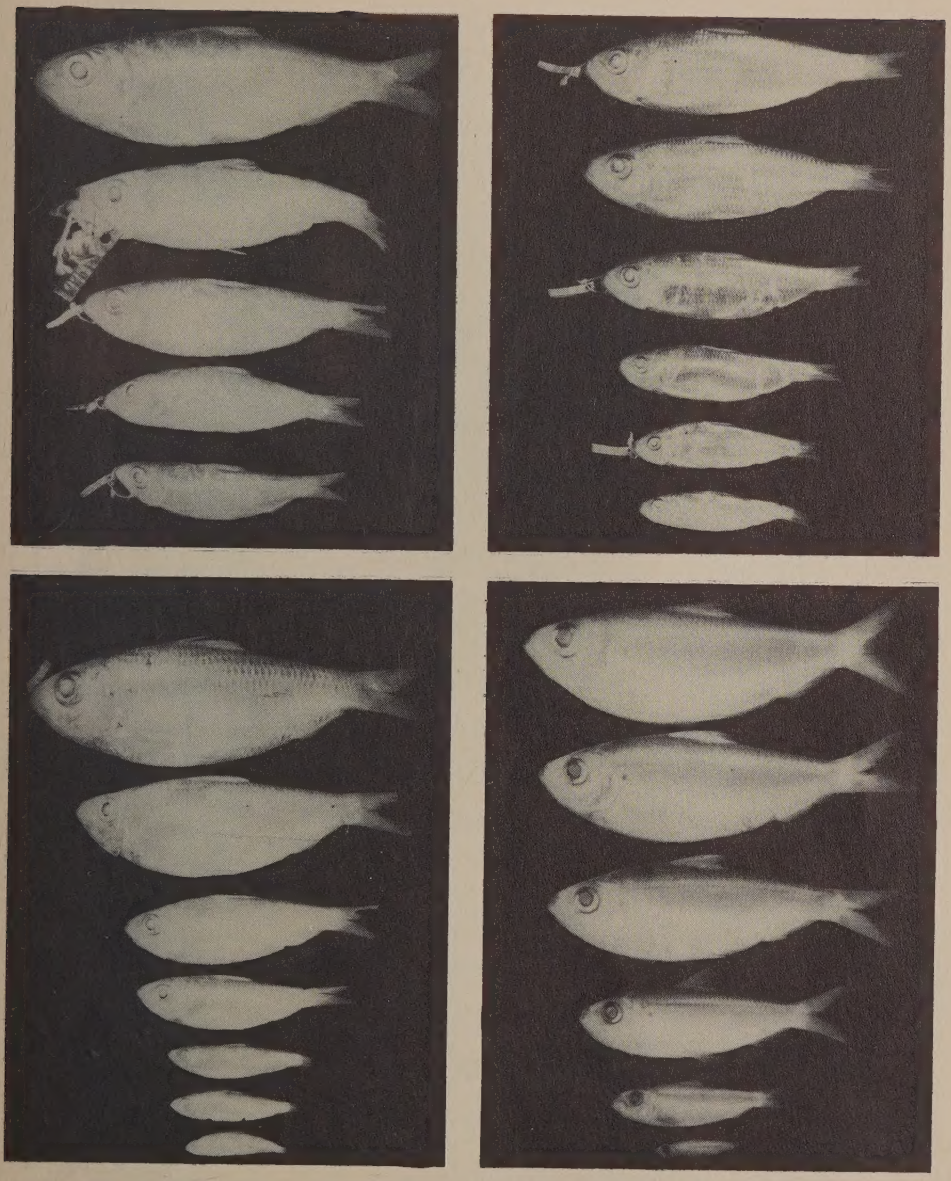


Fig. 2. Series of West Indian species of *Harengula*. Upper left: *H. humeralis* (alcohol), Stanford Coll. (1, Fla. Keys; 2,3,4,5, Key West); upper right: *H. clupeola* (alcohol), 1,3,5, Stanford Coll.; 2,4,6, Acad. Coll. (Havana); lower left: *H. pensacolae* (alcohol), 1, Stanford Coll. (Fla. Keys); 2,3,4,5,6, Acad. Coll. (Key West); lower right: *H. pensacolae* (formaldehyde-fixed), (Sanibel, Fla.). Top fish, upper left, standard length 121.7 mm.

Fig. 3. X-ray positive of Clupeid fishes, from Stanford Collection. Top: the doubly-armored *Ethmidium maculatum* (Chile); middle: *Harengula humeralis* (Havana); bottom: *H. clupeola* (Jamaica). Natural size.

Fig. 4. X-ray positive of Clupeid fishes, and an anchovy, from Sanibel, Fla. Top: *Harengula pensacolae*; middle: *Opisthonema oglinum*; bottom: *Anchoviella epsetus*. Natural size.

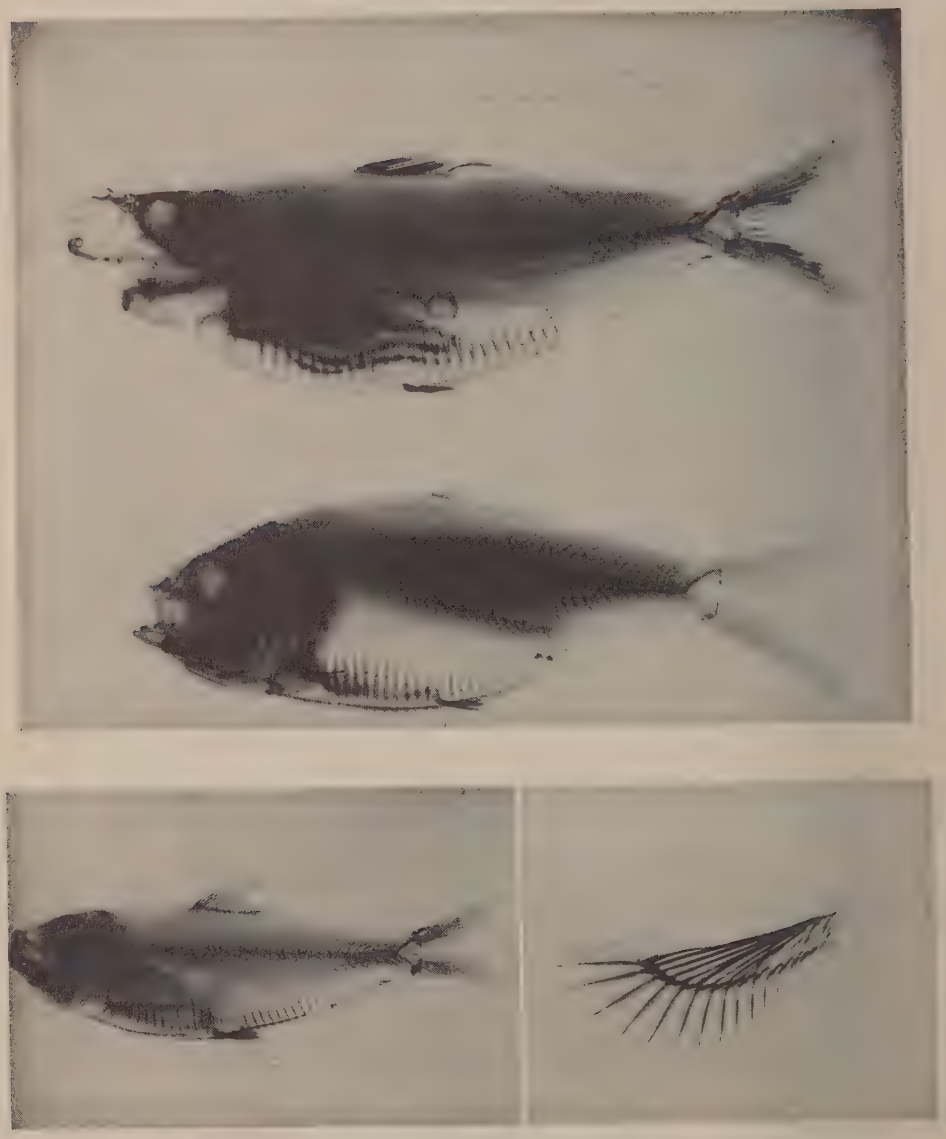


Fig. 5. Cleared and stained Clupeidae from Sanibel, Florida. Top: *Opisthonema oglinum*; middle: *Brevoortia tyrannus*; lower left: *Harengula pensacolae*. Natural size. Lower right: dorsal fin complex of *H. pensacolae*, showing extension caudad of supporting bone of last dorsal ray.

etc., specimens fixed in formaldehyde tend to be more slender. This variation is so pronounced as to render the depth-in-length proportion useless if, for instance, a series of specimens of *Harengula pensacolae* in formaldehyde is compared with a similar series of either *H. humeralis* or *H. clupeola* in alcohol. Yet for series in the same preservative, this proportion may serve as a fairly good distinguishing character.

For this study, data from formaldehyde and alcohol specimens are included, because, although it renders the descriptions a little less clear-cut in many particulars, it insures a wider usefulness. From the general statistical study, only the data for the Sanibel formaldehyde specimens of *H. pensacolae* have been excluded. These are treated and discussed on pages 34 and 35.

Alcohol-preserved Clupeids appear deeper, shorter, and laterally more compressed; formaldehyde-fixed specimens are definitely more fusiform, even after many subsequent years in alcohol. Formaldehyde-fixed fishes retain their scales much better, but the silver soon disappears; the eyes remain full, and the adipose lids are always more prominent. Both preservatives remove most of the color in time (alcohol by far the sooner), but the markings on the formaldehyde specimens are consistently more striking.

CLUPEIDAE CLOSELY RELATED TO *HARENGULA*

Although little work was done on Clupeidae other than *Harengula* for the present study, X-rays and photographs of cleared and stained specimens were made both of *Harengula* and of representatives of other genera, as well as of an anchovy, *Anchoviella,* and are reproduced herewith (figs. 3, 4, and 5).

Attention is called to the presence and shape of the distal parts of the vertical bones that extend dorsad in a series between the occiput and the dorsal fin. Valenciennes (Cuvier and Valenciennes, 1847, p. 47) refers to similar bones in the herring as "interépineux supérieurs"; while Matthews (1887, p. 272), in his description of the skeleton of the herring, calls them interspinous bones, and notes their absence caudad from the dorsal fin. Norman (1923), discussing the genus *Pristigaster,* refers to them as supraneural bones. Their shape, as they near the surface, in genera lacking dorsal scutes, is rather suggestive of scutes. In worn specimens of *Harengula,* from which the scales have been lost, these bones appear as blunt, whitish elements, rising above the level of the surrounding skin. The photographs of cleared specimens of *Brevoortia* and *Opisthonema* (fig. 5) and the X-rays of the latter (fig. 4) show the same broadening and clubbing distally. (In *Anchoviella epsetus* these bones appear slender throughout.) The X-ray of the doubly-armored *Ethmidium maculatum* (fig. 3) shows the dorsal scutes to be more numerous than the supraneural bones, which, in this species, apparently remain notably slender throughout. In 11 of 12 genera of Clupeidae lacking dorsal scutes, the tips of the supraneurals could be seen or readily felt at the surface, usually as short bars, lying along the dorsal axis, of varying widths, often pointed at the sides. *Harengula* has 7 supraneurals.

In cleared specimens of *Brevoortia, Opisthonema, Harengula,* and even of *Anchoviella,* the supporting bone (interneural) of the last dorsal fin-ray turns posteriorly as it meets that ray, and continues for varying distances caudally, evidently becoming cartilaginous (fig. 5). Matthews, who refers to this in the British herring, finds the same situation in the anal fin complex of that species.

KEY TO THE GENERA OF CLUPEIDAE OF THE WESTERN ATLANTIC AND ATLANTIC DRAINAGE STREAMS BETWEEN LABRADOR AND SOUTHERN BRAZIL[1]

1a. Anal fin short, less than 30 rays, except in *Dorosoma*, which has an inferior mouth.
2a. Median notch present in upper jaw.
3a. Gill-rakers of epibranchial of first arch folding downwards, those near the angle overlapping the gill-rakers of the ceratobranchial; gill-cover with radiating grooves, rarely nearly smooth; last rays of dorsal not prolonged into a filament.
4a. Scales with edges entire or feebly serrated; pelvic fins 9-rayed.
5a. Lower jaw not prominent, its tip included.....*Alosa*
5b. Lower jaw projecting.....*Pomolobus*
4b. Scales with edges serrate in young, pectinate in adults; pelvic fins 7-rayed.....*Brevoortia*
3b. Gill-rakers of epibranchial of first arch not folding downwards over those of the ceratobranchial; gill-cover smooth; last rays of dorsal prolonged into a filament.
6a. Mouth terminal; maxillary round; 2 supramaxillaries.....*Signalosa*[2]
6b. Mouth subterminal or inferior; 1 supramaxillary.....*Dorosoma*
2b. No distinct median notch in upper jaw.
7a. Bilobed dermal fold on vertical anterior edge of cleithrum.
8a. Last 2 rays of anal much enlarged, almost forming separate finlets, the third from the last smaller than the one preceding it.....*Sardinella*
8b. Last 2 rays of anal scarcely enlarged, the third from the last not smaller than the one preceding it.
9a. Last ray of dorsal produced into a whip.....*Opisthonema*
9b. Last ray of dorsal not produced.....*Harengula*
7b. No bilobed dermal fold on vertical anterior edge of cleithrum.
10a. No lateral silvery band; 55 - 65 scales longitudinally.....*Clupea*[3]
10b. Silvery lateral band present (often faint in *Rhinosardinia*); less than 55 scales longitudinally.
11a. Body not notably compressed; no scales on lobes of caudal fin; spine or spines near proximal end of maxillary blunt if present.....*Lile*
11b. Body strongly compressed; scales on base of caudal lobes; 1 pointed retrorse spine near proximal end of maxillary.....*Rhinosardinia*[4]
1b. Anal fin long, more than 32 rays; mouth never inferior.
12a. Maxillary not adherent to premaxillary; no canines present.
13a. Pelvic fins absent.
14a. Depth in length 1.8 - 2.0; anal 45 - 55, origin behind dorsal origin; maxillary not tapering behind, not reaching beyond eye.....*Pristigaster*
14b. Depth in length 4.0 - 4.75; anal 67 - 78, origin in front of dorsal origin; maxillary tapering behind in adults, extending to gill-opening or beyond.....*Odontognathus*
13b. Pelvic fins present.....*Neosteus*
12b. Maxillary adherent to premaxillary; canines present.....*Chirocentrodon*[5]

[1] With the exception of *Pseudochirocentrodon* Miranda-Ribeiro (1920), which seems to differ from *Chirocentrodon* in the more anterior dorsal. Key compiled largely from revisions by Regan (1916, 1917a, 1917b, 1917c, 1922) and Norman (1923).
[2] *Signalosa* has been revised by Weed (1925).
[3] *Clupea* (South American) has been revised by Norman (1937).
[4] *Rhinosardinia* replaces *Heringia*; Myers (1929).
[5] *Medipellona* Jordan and Seale (1926) is a synonym of *Chirocentrodon*; Myers (1929).

GENUS *HARENGULA*

Genotype *Harengula latulus* Cuvier and Valenciennes 1847, p. 280, pl. 595, by original designation of Cuvier and Valenciennes 1847, pp. 277 and 281; also designated by Gill 1861, p. 36, Jordan and Gilbert 1882a, p. 268, and Jordan 1919, p. 221 (*nec Clupea latulus* Cuvier 1829).
(For complete citations see Bibliography; for discussion see Nomenclatural Notes.)

Regan (1917b) separates *Harengula* from *Sardinella* and *Sardina*[e] (which he states has no West Indian representative) by its continuous posterior anal fin-rays. In *Sardinella* and *Sardina*, the third ray from the last is shorter than the one preceding it, and the last two are enlarged and separated, resembling finlets. In *Harengula*, the lower jaw is more prominent, and the sheath at the base of the dorsal fin is lower than in *Sardinella*. He also notes, as does Giltay (1933), that the inner ends of the roughly parallel transverse grooves on the scales of the latter are separated by an interspace, while they are continuous in *Harengula* (fig. 9). *Sardina*, restricted by Hubbs (1929) to the European species, differs widely from both *Sardinella* and *Harengula* in the scales; these are of two sizes, and every oblique row that is visible conceals the row behind it, which is formed of smaller scales. The Pacific species, referred to *Sardina* by Regan (1916), are placed in a new genus, *Sardinops*, by Hubbs.

QUANTITATIVE CHARACTERS. A statistical comparison of 16 proportions, angles, and counts of the four West Indian species has been made. Table 3 is a compact summary of the findings, graphically represented in figures 7 and 8. These results are discussed later. The methods employed are outlined below.

Frequency tables, for all proportions and counts made for each species, were set up in the usual manner, usually employing small class intervals for accuracy of results. The classes were designated by their mid-values; i.e., if the class interval "CI" was .025, the value 4.0 includes all values between 3.9875 and 4.0125, while 4.025 includes all between 4.0125 and 4.0375.

From the frequency tables, the average (arithmetic mean) "M," the standard deviation "s," and the standard error of the mean "SE_M" were calculated. Then the species were paired (*humeralis-clupeola*, *humeralis-pensacolae*, etc.), the difference of the means "D" was determined, the standard error of the difference "SE_D" calculated, and the relative deviate of the difference between the means "RD," and the probability of the relative deviate "p" for each difference secured. The probability p is the probability that an observed difference of means has occurred as a result of sampling errors *only*, on the assumption that the true difference is zero (Fisher 1928). A high value of p therefore indicates that the observed difference of the means might easily have arisen as the result of chance only, and cannot be considered to be biologically significant. Low values of p, on the contrary, indicate that the differences *are* significant, and have probably not arisen solely as a result of sampling error. Table 2, after Fisher 1928, shows the probabilities of chance occurrence of a few

Table 2. Relative deviates and probabilities. (Fisher 1928.)

RD	p
.6745	.50
1.0	.320
2.0	.045
3.0	.006
4.0	.0001
5.0	.000001
6.0	.00000001

[e] De Buen (1935, p. 43) has shown that *Arengus* Cornide 1788 replaces *Sardina* Antipa 1905.

Table 3. Constants of the frequency distributions and comparison of differences between means for *Harengula humeralis* (hum), *H. clupeola* (clu), *H. pensacolae* (pen), and *H. majorina* (maj). N = number of specimens; CI = class interval; M = mean; s = standard deviation; D = difference; SE_D = standard error of difference; RD = relative deviate; p = probability of chance occurrence; - = "less than" the value given (see table 2).

	N	CI	M	s	Pairs	D	SE_D	RD	p	Pairs	D	SE_D	RD	p
Depth/Length														
hum	42	.05	3.181	.138	hum-clu	.057	.032	1.77	.077-	hum-maj	.369	.048	7.62	.001-
clu	46	.05	3.238	.163	hum-pen	.311	.026	11.88	.001-	clu-maj	.426	.050	8.6	.001-
pen	63	.05	2.87	.122	clu-pen	.368	.028	12.9	.001-	pen-maj	.058	.046	1.26	.24
maj	13	.05	2.812	.156										
Eye/Length														
hum	42	.1	9.45	.362	hum-clu	1.146	.080	14.37	.001-	hum-maj	.835	.090	9.3	.001-
clu	46	.1	10.596	.386	hum-pen	.745	.076	9.75	.001-	clu-maj	.311	.090	3.44	.001-
pen	63	.1	10.195	.414	clu-pen	.401	.077	5.2	.001-	pen-maj	.09	.087	1.03	.3
maj	13	.1	10.285	.253										
Head Depth/Length														
hum	42	.05	4.888	.116	hum-clu	.104	.033	3.14	.002-	hum-maj	.226	.069	3.27	.001-
clu	46	.05	4.992	.19	hum-pen	.132	.025	5.4	.001-	clu-maj	.330	.072	4.57	.001-
pen	63	.05	4.755	.134	clu-pen	.237	.033	7.25	.001-	pen-maj	.093	.069	1.36	.17
maj	13	.05	4.662	.24										
Head/Depth														
hum	42	.025	1.058	.057	hum-clu	.032	.012	2.70	.007-	hum-maj	.234	.026	8.87	.001-
clu	46	.025	1.091	.055	hum-pen	.183	.014	13.45	.001-	clu-maj	.202	.026	7.69	.001-
pen	63	.025	1.241	.082	clu-pen	.151	.013	11.48	.001-	pen-maj	.051	.027	1.89	.06-
maj	13	.025	1.292	.090										
Eye/Depth														
hum	42	.05	2.991	.172	hum-clu	.298	.036	8.32	.001-	hum-maj	.667	.062	10.8	.001-
clu	46	.05	3.289	.163	hum-pen	.574	.038	15.19	.001-	clu-maj	.379	.061	6.23	.001-
pen	63	.05	3.565	.213	clu-pen	.276	.036	7.65	.001-	pen-maj	.093	.062	1.5	.135
maj	13	.05	3.658	.201										
Head Depth/Depth														
hum	42	.025	1.542	.075	hum-clu	.001	.015	.08	.936	hum-maj	.126	.031	4.1	.001-
clu	46	.025	1.543	.060	hum-pen	.117	.015	7.71	.001-	clu-maj	.124	.030	4.18	.001-
pen	63	.025	1.659	.079	clu-pen	.116	.013	8.73	.001-	pen-maj	.008	.030	.28	.78
maj	13	.025	1.667	.102										
Head Depth/Head														
hum	42	.02	1.459	.046	hum-clu	.047	.011	4.45	.001-	hum-maj	.164	.021	7.73	.001-
clu	46	.02	1.412	.053	hum-pen	.120	.010	12.25	.001-	clu-maj	.117	.021	5.44	.001-
pen	63	.02	1.340	.053	clu-pen	.072	.010	7.0	.001-	pen-maj	.044	.021	2.11	.035-
maj	13	.02	1.295	.072										
Opercle/Head														
hum	42	.025	1.861	.065	hum-clu	.065	.013	4.95	.001-	hum-maj	.247	.025	9.96	.001-
clu	46	.025	1.796	.057	hum-pen	.146	.013	11.17	.001-	clu-maj	.182	.024	7.49	.001-
pen	62	.025	1.715	.066	clu-pen	.081	.012	6.77	.001-	pen-maj	.101	.024	4.16	.001-
maj	13	.025	1.613	.082										
	N	CI	M	s	Pairs	D	SE_D	RD	p	Pairs	D	SE_D	RD	p

Table 3, cont'd. Constants of the frequency distributions and comparison of differences between means for *Harengula humeralis* (hum), *H. clupeola* (clu), *H. pensacolae* (pen), and *H. majorina* (maj). N = number of specimens; CI = class interval; M = mean; s = standard deviation; D = difference; SE_D = standard error of difference; RD = relative deviate; p = probability of chance occurrence; - = "less than" the value given (see table 2).

	N	CI	M	s	Pairs	D	SE_D	RD	p	Pairs	D	SE_D	RD	p
Gill-Cover/Head														
hum	42	.02	1.605	.056	hum-clu	.051	.012	4.11	.001-	hum-maj	.206	.018	11.38	.001-
clu	46	.02	1.554	.060	hum-pen	.132	.011	11.49	.001-	clu-maj	.155	.018	8.48	.001-
pen	62	.02	1.473	.060	clu-pen	.081	.012	6.91	.001-	pen-maj	.074	.018	4.2	.001-
maj	13	.02	1.398	.058										
Eye Depth/Head Depth														
hum	42	.025	1.944	.079	hum-clu	.191	.016	11.62	.001-	hum-maj	.239	.031	7.78	.001-
clu	46	.025	2.135	.075	hum-pen	.195	.016	12.0	.001-	clu-maj	.048	.030	1.57	.135
pen	63	.025	2.139	.085	clu-pen	.004	.015	.28	.780	pen-maj	.044	.030	1.43	.155
maj	13	.025	2.183	.101										
Depth at Occiput/Length														
hum	42	.025	3.912	.123	hum-clu	.101	.032	3.16	.002-	hum-maj	.374	.034	11.13	.001-
clu	46	.025	4.014	.176	hum-pen	.307	.023	13.5	.001-	clu-maj	.475	.038	12.52	.001-
pen	63	.025	3.605	.100	clu-pen	.408	.029	14.18	.001-	pen-maj	.067	.030	2.2	.03-
maj	13	.025	3.538	.100										
Anterior Body Angle														
hum	42	1.0	32.98	1.93	hum-clu	.17	.437	.39	.697	hum-maj	6.48	.745	8.7	.001-
clu	46	1.0	33.15	2.17	hum-pen	5.37	.424	12.67	.001-	clu-maj	6.31	.757	8.34	.001-
pen	63	1.0	38.35	2.385	clu-pen	5.20	.44	11.81	.001-	pen-maj	1.11	.749	1.48	.14
maj	13	1.0	39.46	2.47										
Posterior Body Angle														
hum	42	1.0	34.81	2.145	hum-clu	1.31	.61	2.15	.031	hum-maj	4.27	1.143	3.73	.001-
clu	46	1.0	33.5	3.48	hum-pen	2.09	.498	4.2	.001-	clu-maj	5.58	1.22	4.58	.001-
pen	63	1.0	36.9	2.95	clu-pen	3.4	.634	5.37	.001-	pen-maj	2.18	1.156	1.88	.06-
maj	13	1.0	39.08	3.95										
Ventral Body Angle														
hum	42	1.0	137.98	3.7	hum-clu	.40	.915	.44	.66	hum-maj	10.51	1.915	5.5	.001-
clu	46	1.0	138.38	4.85	hum-pen	7.85	.874	8.99	.001-	clu-maj	10.91	1.961	5.57	.001-
pen	63	1.0	130.13	5.245	clu-pen	8.25	.971	8.5	.001-	pen-maj	2.66	1.942	1.37	.17
maj	13	1.0	127.47	6.585										
Gill-Raker Count														
hum	42	1.0	28.215	.916	hum-clu	3.565	.262	13.61	.001-	hum-maj	5.325	.459	11.6	.001-
clu	46	1.0	31.78	1.498	hum-pen	8.815	.204	43.1	.001-	clu-maj	1.76	.489	3.59	.001-
pen	63	1.0	37.03	1.17	clu-pen	5.25	.266	19.78	.001-	pen-maj	3.49	.461	7.58	.001-
maj	13	1.0	33.54	1.571										
Ventral Scute Count														
hum	42	1.0	27.5	.64	hum-clu	3.065	.152	21.7	.001-	hum-maj	3.579	.221	16.2	.001-
clu	46	1.0	30.565	.785	hum-pen	2.29	.131	17.5	.001-	clu-maj	.514	.229	2.24	.025
pen	62	1.0	29.79	.678	clu-pen	.775	.144	5.37	.001-	pen-maj	1.289	.215	5.99	.001-
maj	13	1.0	31.079	.710										

N	CI	M	s	Pairs	D	SE_D	RD	p	Pairs	D	SE_D	RD	p

selected values of the relative deviate. It is usual to consider that differences for which the value of p is greater than .1 are not statistically significant; that differences for which p is .05 are moderately significant; while differences for which p is .01 or less are highly significant.

It may be seen from table 3 that the species are separated each from the other in the majority of the proportions and counts by very large relative deviates, with the probability that the observed differences are due solely to chance being usually less than one in a thousand. Of 96 relative deviates, 51 are over 6.0 (the largest relative deviate Fisher gives, see table 2), and only 24 are under 3.5 (or a value corresponding to a probability of .001, or one chance in a thousand). Eight of the nine under 3.5 in the center column are in the *humeralis-clupeola* pairings, yet in the characters of the greatest importance diagnostically (gill-raker and ventral scute counts, fig. 8, and scale characters, fig. 9), these two species are very widely separated. Thirteen relative deviates under 3.5 are in the *pensacolae-majorina* pairings, yet these species are also well separated in essential characters.

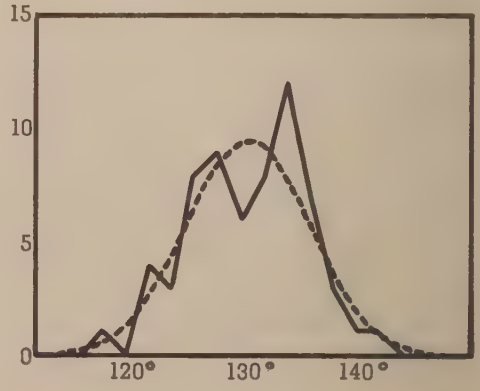
Curves, made from the data in the frequency tables, graphically present the percentage frequency distributions of the proportions and angles for each species (fig. 7). The data were smoothed by threes three times before plotting, in order to eliminate insignificant irregularities.

The evidence of multimodality in some of the curves causes more interest than concern. In checking back through the material, it was found that in each case one or more of the following factors could have contributed to such irregularities: discontinuous series as to size, locality, preservative; size of interval employed in tabulating data; variations within the species (of which there is considerable evidence); and possibly sex, year caught, time in preservative, etc. Nevertheless, tests were made to determine the statistical significance of

Table 4. Observed and calculated frequency tables, ventral body angle of *H. pensacolae*.

Angle	O	C
114°		.12
116°		.19
118°	1	.51
120°		1.26
122°	4	2.52
124°	3	4.35
126°	8	6.49
128°	9	8.38
130°	6	9.45
132°	8	9.20
134°	12	7.75
136°	7	5.80
138°	3	3.60
140°	1	1.96
142°	1	.95
144°		.38
146°		.12
N	63	63.03
M	130.13	
s	5.245	

Fig. 6. Percentage frequencies of ventral body angle for *H. pensacolae* (——); with superimposed normal curve fitted to data (---).



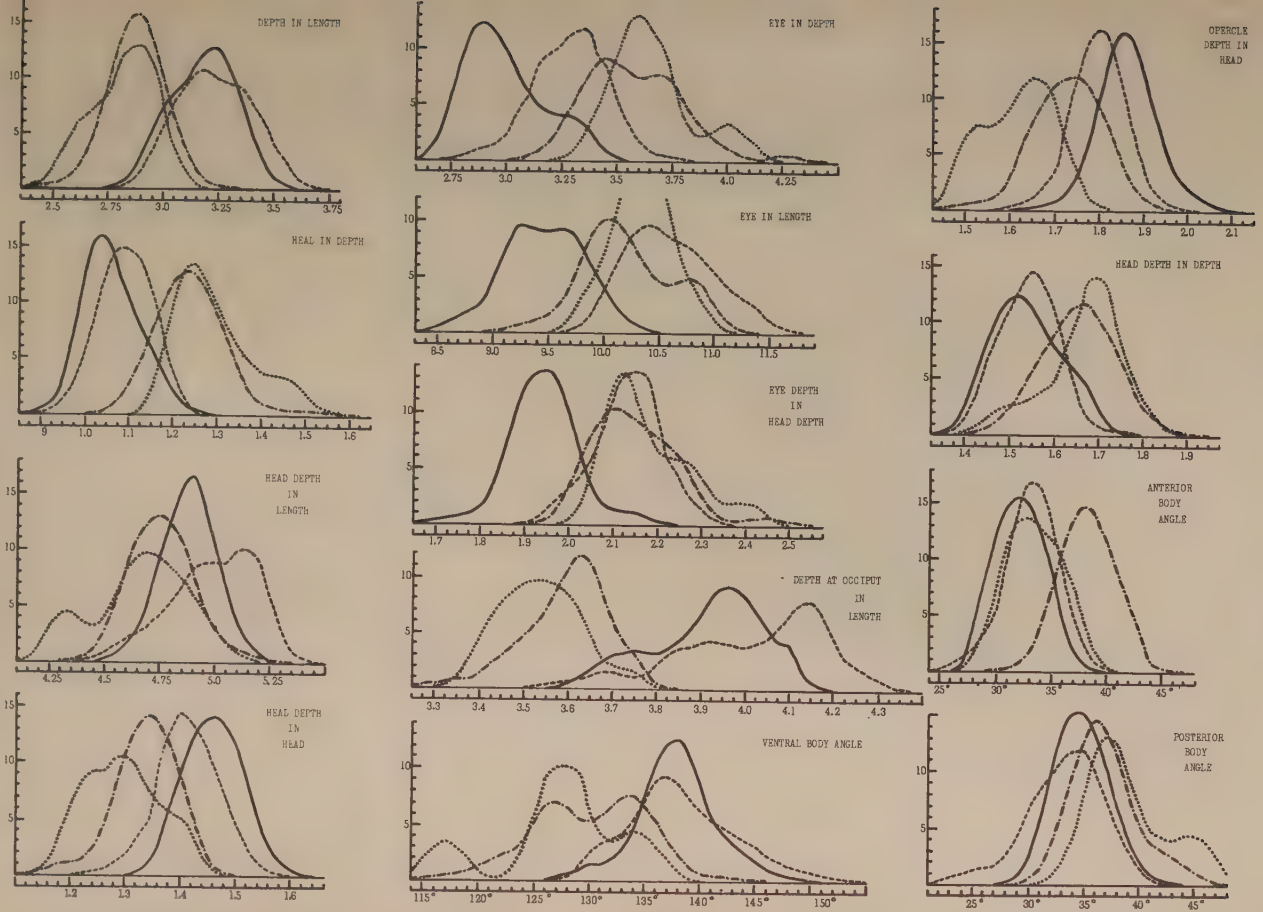


Fig. 7. Graphs of smoothed percentage frequency distributions of 13 proportions for the West Indian species of *Harengula*: *H. humeralis* (——); *H. clupeola* (----); *H. majorina* (····); *H. pensacolae* (-·-·-·).

one of the most irregular of these curves, that for the ventral body angle of *H. pensacolae*. From the frequency table, the mean M (130.13), the standard deviation s (5.245), and the number of specimens N (63) were determined, and a normal frequency distribution having these same values was calculated. The observed "O" and the calculated "C" values are presented in table 4, and are shown graphically in figure 6. Fisher's chi-square test was then applied, to determine the "goodness of fit" of the observed to the theoretical distribution. For this test, the ends of both distributions were "lumped," so that the total number of classes was 9, and the "degrees of freedom" 7. Chi-square was found to be 5.04, and for these values, p is .544, which may be interpreted to mean that such a variation from the normal would occur by chance about half the time. In other words, the apparent bimodality cannot be proved to be statistically significant.

Histograms, in percentage frequencies, of the gill-raker and ventral scute counts for the four species are shown in figure 8.

Buchanan-Wollaston (1933), in a critical analysis of the data presented by Schnakenbeck (1931), shows that the latter's empirical method for distinguishing herring races by their vertebral counts is unsound, and that differences emphasized by him are due "entirely to the varying position of the mean in the group interval." Since the gill-raker and ventral scute count data are comparable, being highly grouped, discrete variables (whereas those of the proportions and

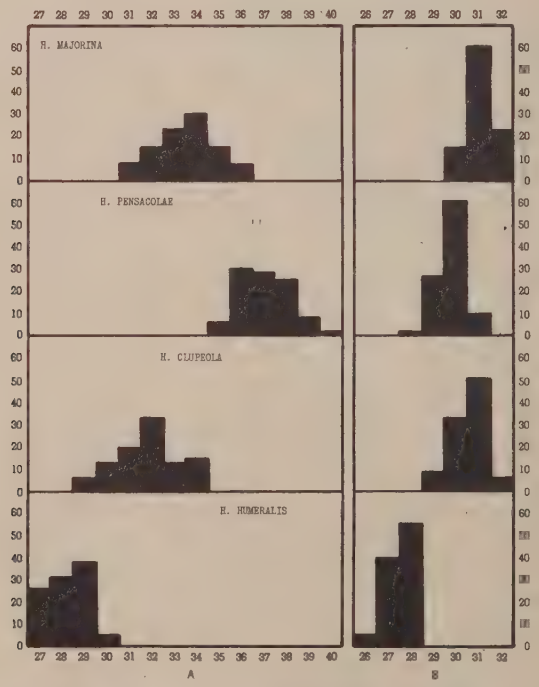


Fig. 8. Histograms, in percentage frequencies, showing distribution of gill-raker (A) and ventral scute (B) counts for the West Indian species of *Harengula*.

body angle measurements are continuous variables), it seems safe to assume that the same methods are applicable, and that, therefore, one may depend upon the means as efficient descriptions of the central tendencies, and on the significance of differences between the means as measures of the extent to which the groups differ from one another.

QUALITATIVE CHARACTERS. The tip of the dorsal fin and the tips of the inside rays of the caudal in *H. humeralis* are blackish even in alcohol specimens. Fresh and formaldehyde-fixed specimens of *H. clupeola* and of *H. pensacolae* show some pigmentation on the dorsal and caudal, and of *H. majorina* on the caudal, but never enough to be striking. Pectorals, ventrals, and anals are always pale in preservative. All four species (and *H. thrissina*) show evidence of a humeral spot, faintest on *H. humeralis*. All usually show faint to strong traces of one to four or five series of dark lateral markings, which sometimes break up into dots, above the level of the humeral spot. The snout, tip of lower lip, and the dorsum are in all cases dusky. In alcohol, the scales are brightly silvered.

Scale analyses, heretofore, have largely ignored the striking, and often characteristic, differences in scales from different parts of the same fish. Figure 9 demonstrates the importance of stating the exact location of any scale described.

The most important scale characters are shown in figure 9, in the key to the species, and in the descriptions. Of the likenesses, on the other hand, in all of the American species of *Harengula*, the transverse grooves in the lateral scales are continuous, and roughly parallel, often with a dip in the midsection of the scale. The number of grooves vary rather widely with the part of the fish from which the scale was taken (fewer cephalad and ventrad, more numerous dorsad and caudad), as well as with the species. In *H. humeralis* and *H. majorina*, in anterior lateral and low lateral scales, grooves are often aberrant, being neither continuous nor parallel. Scales from the midline of the caudal peduncle each bear a longitudinal groove, beginning anteriorly and forking near the point where the scale becomes exposed, each fork continuing its divergent course to the free margin of the scale. The transverse grooves are numerous, and follow tortuous courses, especially in the anterior part of the scale. Scales from the dorsal and ventral regions of the caudal peduncle are a mass of twisting grooves, the less elaborate patterns appearing on the ventrad side of the dorsal, and on the dorsad side of the ventral scales.

VALUE OF CHARACTERS. The most important characters, i.e., those which best serve to separate the four West Indian species, appear to be the gill-raker and ventral scute counts (fig. 8). The proportions of depth at occiput in length, eye in length, eye in depth, head depth in head, opercle and gill-cover depths in head, also provide fairly good characters, which set each species apart. One species (not always the same one) may be distinguished from the others by the following: depth in length, head in depth, head depth in depth, eye depth in head depth, the three body angles, certain scale characters, fin pigmentation, etc. Despite the very small series (13 specimens), with a consequent large standard error (which materially reduces the relative deviate, thus correspondingly increasing the probability of chance occurrence), pairings of *H. majorina* with the other species show statistically significant differences; from *H. humeralis* and *H. clupeola* in all but two proportions and counts, and from *H. pensacolae* not only in the raker and scute counts, but also in the proportions head depth in head, opercle depth in head, gill-cover depth in head, depth at occiput in length, and in the posterior body angle. The following, long used to distinguish

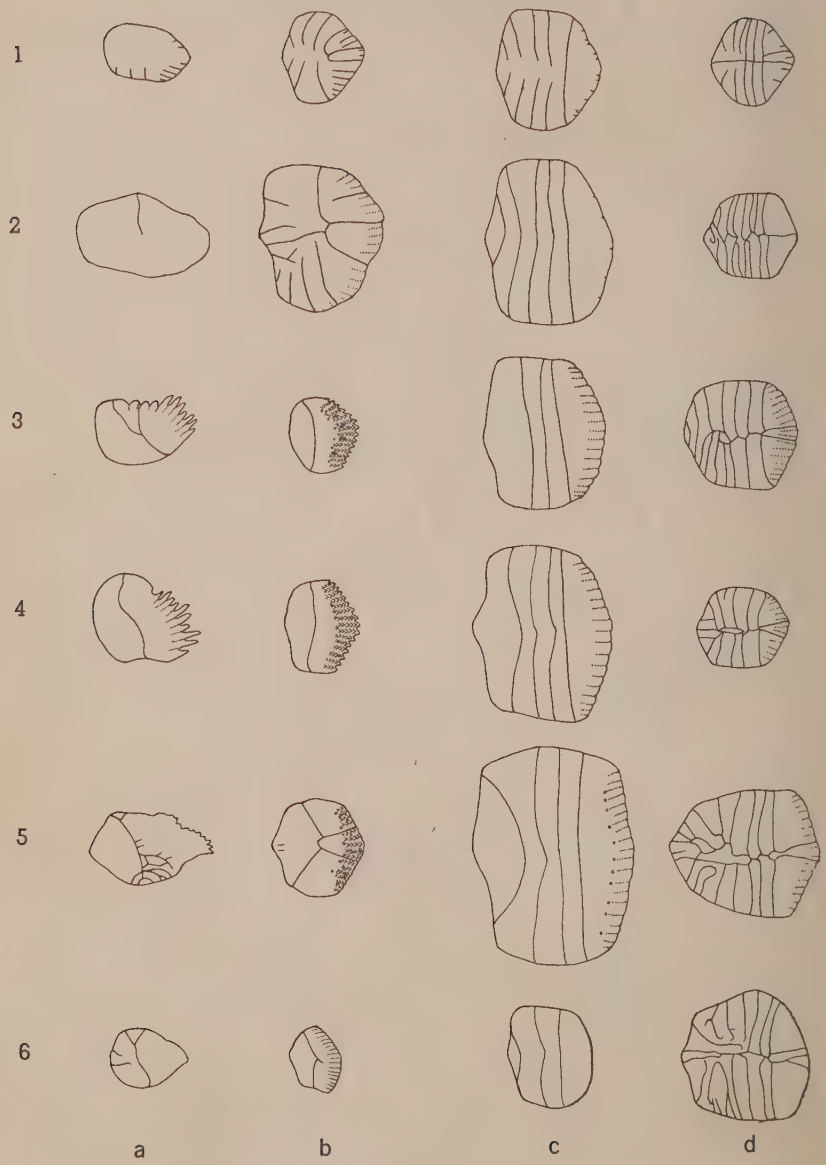


Fig. 9. Clupeid scales. Species, by row: (1) *Sardinella aurita;* (2) *Harengula humeralis;* (3) *H. clupeola;* (4) *H. pensacolae;* (5) *H. majorina;* (6) *H. thrissina.* Loci, by column: (a) ventrad prepectoral region; (b) dorsum cephalad of dorsal fin; (c) midsection, midlateral; (d) midsection of caudal peduncle, midlateral. Drawn from large specimens and photographs. Enlarged 3 x.

species of *Harengula*, differentiate so poorly that they may be used for generic characters, in the West Indian forms, at least: head in length, eye in head, eye to preopercle in eye, snout in eye, opercle and gill-cover depths in head depth, scale counts, and dorsal and anal fin-ray counts.

CHARACTERS COMMON TO AMERICAN HARENGULAS. Head in length 3.1 - 3.9; depth in length 2.5 - 3.55 (*H. thrissina* 3.35 - 3.65); eye in head 2.5 - 3.3; snout in eye 1.1 - 1.5; eye to preopercle in eye 1.0 - 1.4; opercle depth in head depth 1.2 - 1.4; gill-cover depth in head depth 1.0 - 1.2; scales 38 - 42 longitudinal count, 11½ transverse count (*H. thrissina* 12½ - 13½ transverse); dorsal fin-ray count 17 - 20; anal 17 - 20 (*H. thrissina* anal 15 - 16); ventral 8 (Regan, 1917b); transverse grooves in lateral scales from midsection continuous and roughly parallel; humeral spot and lateral markings usually present; vertebrae 40 - 44 (Regan 1917b), (*H. thrissina* 43 or 44); supraneurals 7 (figs. 3, 4, 5).

SUMMARY OF FINDINGS. *Harengula humeralis* is so widely separated from the other species in all key characters that it might almost be placed in a separate subgenus. *H. clupeola*, *H. pensacolae*, and *H. majorina* are much closer to each other than any one of them is to *H. humeralis;* yet valid and constant differences exist, and are demonstrable. In other words, it is comparatively easy to describe and defend these three species, but quite impossible, in the light of present findings, to prove they are but one. In fact, a study of comprehensive material may make it necessary to distinguish subspecific categories within these species.

LOCALITIES. The specimens for this study came from the localities shown in table 5. There are too few localities and too few specimens to draw definite conclusions about ranges, but apparently *H. majorina* has the southernmost habitat, *H. pensacolae* is confined to the Gulf of Mexico, while *H. humeralis* and *H. clupeola* range over most of the Caribbean, and to the Bahamas, at least, but are not found on the mainland of the Gulf coast of Florida.

Table 5. Localities from which specimens were taken.

Locality	*H. humeralis*	*H. clupeola*	*H. pensacolae*	*H. majorina*
Prov. of São Paulo, Brazil				X
Santos, Brazil				X
Panama		X		
Glover Reef, Br. Honduras	X	X		
St. Lucia, B.W.I.	X	X		X
"West Indies"				X
Porto Rico		X		
Jamaica	X	X		
Cuba	X	X		
Bahamas	X	X		
Garden Key, Florida		X		
"Florida Keys," Fla.	X		X	
Cape Sable, Fla.			X	
Sanibel, Fla.			X	
Egmont Key, Fla.			X	
Cedar Keys, Fla.			X	
Pensacola, Fla.			X	
Galveston, Texas			X	
Yucatan, Mexico			X	

KEY TO THE WEST INDIAN SPECIES OF *HARENGULA*

If a specimen approaches the average (arithmetic mean) given for the first few counts and proportions it should be unnecessary to key it to the end; proceed immediately to the description of the species indicated. The complete key is primarily to facilitate identification of the more aberrant specimens.

1a. Gill-rakers below angle of first arch 27 - 30 (28.2).[7]
2a. Ventral scute count 14 - 16 + 11 - 13 = 26 - 28 (27.5).
3a. Scales thin, glassy, usually entire in ventrad prepectoral, dorsal, and lateral regions; 4 - 5 (4+) transverse grooves on midlateral scales of midsection, often not parallel or continuous on scales cephalad and ventrad.
4a. Tips of longest dorsal rays and inside margins of caudal lobes blackish; humeral spot usually present, but faint.
5a. Depth at occiput in length 3.65 - 4.1 (3.9).
6a. Anterior body angle 30° - 37° (33°); posterior body angle 31° - 40° (34.8°); ventral body angle 130° - 147° (138°).
7a. Depth in length 2.95 - 3.4 (3.2); head depth in length 4.65 - 5.15 (4.9).
8a. Eye in length 8.7 - 10.1 (9.45); eye in depth 2.8 - 3.35 (3.0); eye in head 2.7 - 3.0 (2.8); eye depth in head depth 1.75 - 2.15 (1.95).
9a. Head in depth .95 - 1.2 (1.05); head depth in depth 1.4 - 1.7 (1.55).
10a. Head depth in head 1.4 - 1.55 (1.45).
11a. Opercle depth in head 1.7 - 2.0 (1.85); gill-cover depth in head 1.5 - 1.75 (1.6).....*H. humeralis*

1b. Gill-rakers below angle of first arch 29 - 34 (31.8).
2b. Ventral scute count 15 - 18 + 13 - 16 = 29 - 32 (30.55).
3b. Scales thicker than those of *H. humeralis*, not glassy, dorsal and sometimes lateral scales crenulated, fenestrated; first ventrad prepectoral scales bear several long, flat, fingerlike projections on free edges; midlateral scales from midsection with 2 - 3 (3) transverse grooves.
4b. Dorsal and caudal fins lightly pigmented, never blackish; humeral spot present.
5b. Depth at occiput in length 3.6 - 4.3 (4.0).
6b. Anterior body angle 28° - 37° (33.15°); posterior body angle 25° - 40° (33.5°); ventral body angle 130° - 150° (138.4°).
7b. Depth in length 2.95 - 3.55 (3.25); head depth in length 4.55 - 5.25 (5.0).
8b. Eye in length 10.0 - 11.4 (10.6); eye in depth 2.9 - 3.55 (3.3); eye in head 2.9 - 3.2 (3.0); eye depth in head depth 2.0 - 2.3 (2.15).
9b. Head in depth 1.0 - 1.2 (1.1); head depth in depth 1.4 - 1.7 (1.55).
10b. Head depth in head 1.3 - 1.5 (1.4).
11b. Opercle depth in head 1.65 - 1.9 (1.8); gill-cover depth in head 1.4 - 1.7 (1.55).....*H. clupeola*

[7] Arithmetic mean.

1c. Gill-rakers below angle of first arch 31 - 36 (33.55), Brazil[e] (32.5).
2c. Ventral scute count 15 - 17 + 13 - 16 = 30 - 32 (31.1), Brazil (30.85).
3c. Scales thicker than those of *H. humeralis*, not glassy, dorsal and sometimes lateral scales crenulated, fenestrated; first ventrad prepectoral scales bear projections on free edges, usually many, short, and sharply pointed; midlateral scales from midsection with 3 - 5 (4) transverse grooves, often not continuous or parallel in scales cephalad and ventrad.
4c. Dorsal and caudal fins lightly pigmented; tips of longest rays of upper caudal lobe blackish in formaldehyde-fixed specimens; humeral spot present.
5c. Depth at occiput 3.4 - 3.7 (3.55)[e], Brazil (3.5).
6c. Anterior body angle 36° - 43° (39.45°), Brazil (40.8°); posterior body angle 34° - 46° (39.1°), Brazil (41.0°); ventral body angle 116° - 136° (127.45°), Brazil (124°).
7c. Depth in length 2.55 - 3.0 (2.8), Brazil (2.7); head depth in length 4.3 - 5.0 (4.65), Brazil (4.7).
8c. Eye in length 9.9 - 10.7 (10.3), Brazil (10.25); eye in depth 3.4 - 4.05 (3.65), Brazil (3.8); eye in head 2.75 - 3.0 (2.85), Brazil (2.75); eye depth in head depth 2.05 - 2.4 (2.2), Brazil (2.15).
9c. Head in depth 1.2 - 1.45 (1.3), Brazil (1.35); head depth in depth 1.45 - 1.8 (1.65), Brazil (1.7).
10c. Head depth in head 1.2 - 1.4 (1.3), Brazil (1.25).
11c. Opercle depth in head 1.5 - 1.7 (1.6), Brazil (1.55); gill-cover depth in head 1.3 - 1.5 (1.4), Brazil (1.35).....*H. majorina*

1d. Gill-rakers below angle of first arch 34 - 40 (37.05).
2d. Ventral scute count 15 - 17 + 13 - 15 = 28 - 31 (29.8).
3d. Scales thicker than those of *H. humeralis*, not glassy, dorsal and sometimes lateral scales crenulated, fenestrated; first ventrad prepectoral scales bear several long, flat, fingerlike projections on free edges; midlateral scales from midsection with 2 - 4 (3.7) transverse grooves.
4d. Dorsal and caudal fins lightly pigmented, never blackish; humeral spot present.
5d. Depth at occiput in length 3.3 - 3.8 (3.6).
6d. Anterior body angle 33° - 44° (38.35°); posterior body angle 32° - 44° (36.9°); ventral body angle 118° - 142° (130.15°).
7d. Depth in length 2.55 - 3.15 (2.85); head depth in length 4.5 - 5.15 (4.75).
8d. Eye in length 9.0 - 11.3 (10.3); eye in depth 3.2 - 3.9 (3.55); eye in head 2.5 - 3.1 (2.85); eye depth in head depth 1.95 - 2.5 (2.15)[e].
9d. Head in depth 1.1 - 1.5 (1.25); head depth in depth 1.45 - 1.85 (1.65).
10d. Head depth in head 1.2 - 1.4 (1.35).
11d. Opercle depth in head 1.5 - 1.9 (1.7); gill-cover depth in head 1.3 - 1.6 (1.5).....*H. pensacolae*

[e] Because the Brazilian specimens as a group are much the largest in my small discontinuous series of *H. majorina*, there is some question as to whether the variation from the mean in many characters is not due to size alone; however, pending further knowledge, and because the holotype is from Brazil, their mean is always indicated.
[e] See description of *H. pensacolae* for discussion of wide variation in eye measurements.

Fig. 10. West Indian species of *Harengula*. Top: *H. humeralis*, Stanford Coll. (Jamaica); middle: *H. clupeola*, Acad. Coll. (east coast of Panama); bottom: *H. pensacolae*, Acad. Coll. (Key West). In alcohol. Natural size.

Fig. 11. West Indian species of *Harengula*. Top: *H. humeralis*, Bing. Coll. (Glover Reef); middle: *H. clupeola*, Bing. Coll. (Glover Reef); bottom: *H. pensacolae* (Sanibel, Fla.). Initial preservative: formaldehyde solution. Natural size.

THE SPECIES OF *HARENGULA* IN THE WEST INDIES

HARENGULA HUMERALIS (CUVIER) 1829.

"Sardine des Antilles" Duhamel 1776, p. 548, pl. 31, fig. 4 (Guadeloupe).
Clupea humeralis Cuvier 1829, p. 318, footnote 2; 1843, p. 274, footnote 1 (on "Sardine des Antilles" of Duhamel). (*nec Harengula humeralis* Cuvier and Valenciennes 1847.)
Harengula maculosa Cuvier and Valenciennes 1847, p. 292 (Martinique). Type: lost.
Alosa apicalis Müller and Troschel 1848, p. 675 (Barbados). Type: probably in Berlin.
Harengula sardina Poey 1860, p. 310 (Cuba). Types: Poey's no. 40, U.S.N.M. no. 4794 (2 specimens); cotypes (?): M.C.Z. attached tag no. 17868 (1 specimen), M.C.Z. unattached tag no. 17736 (2 specimens).
?*Harengula jaguana* Poey 1866, p. 189 (Bahia de Jagua, Cuba). Type: Poey's no. 580, whereabouts unknown.
?*Harengula callolepis* Goode 1880, p. 152 (Bermuda). Type: U.S.N.M. no. 21243.

(For complete citations see Bibliography;
for discussion see Nomenclatural Notes.)

(Figs. 2,3,9,10,11,16, and 17.)

Depth in length 2.95 - 3.4 (3.2)[10]; head in length 3.1 - 3.6 (3.4); head depth in length 4.65 - 5.15 (4.9); eye in length 8.7 - 10.1 (9.45); eye in head 2.7 - 3.0 (2.8); opercle depth in head 1.7 - 2.0 (1.85); gill-cover depth in head 1.5 - 1.75 (1.6); head depth in head 1.4 - 1.55 (1.45); eye depth in head depth 1.75 - 2.15 (1.95); opercle depth in head depth 1.2 - 1.35 (1.3); gill-cover depth in head depth 1.0 - 1.2 (1.1); head in depth .95 - 1.2 (1.05); head depth in depth 1.4 - 1.7 (1.55); eye in depth 2.8 - 3.35 (3.0); eye to preopercle in eye 1.2 - 1.4 (1.3); snout in eye 1.2 - 1.4 (1.3).

Occiput depth in length 3.65 - 4.1 (3.9); anterior body angle 30° - 37° (33°); posterior body angle 31° - 40° (34.8°); ventral body angle 130° - 147° (138°). Gill-rakers below the angle of the first arch 27 - 30 (28.2). Ventral scutes 14 - 16 + 11 - 13 = 26 - 28 (27.5). Dorsal fin-rays 18 - 20 (18.55); anal 17 - 20 (18.2). Scales 38 - 42 longitudinal, 11½ transverse count; thin, glassy, usually entire, never sharp crenulations. Free surfaces of dorsal and lateral scales sometimes bear low radiating ridges, never prominent, and never with fenestrations between ridges. First ventrad prepectoral scales entire, or ragged, never with fingerlike projections at the free edges. Midlateral scales from the midsection with 4 - 7 (4 - 5) parallel and continuous transverse grooves. The grooves are fewer (3 - 4) in scales cephalad and ventrad, where they are frequently neither parallel nor continuous, and more numerous (5 - 10) in the scales dorsad and caudad. Tip of dorsal and inside margin of caudal lobes blackish; pectorals, ventrals, and anal pale in preservative. Lips and dorsum dusky. Humeral spot usually present, seldom striking; evidence of horizontal streakings above the midline laterally.

[10] Arithmetic mean.

A slender, glassy-silver fish, with a long head and strikingly large eyes.

Forty-two specimens, 71 - 141 mm. (102.4 mm.) in standard length, were used for these measurements, from St. Lucia, B.W.I.; Glover Reef, British Honduras; Jamaica; Cuba; Florida Keys; and the Bahamas.

HARENGULA CLUPEOLA (CUVIER) 1829

"Petit Cailleu" Duhamel 1776, p. 546, pl. 31, fig. 2 (Guadeloupe).
Clupea clupeola Cuvier 1829, p. 318, footnote 2; 1843, p. 274, footnote 1 (on "Petit Cailleu" of Duhamel).
Clupea macrophthalma Ranzani 1842, p. 320, pl. 23, fig. 1 (?Brazil). Type: Ist. Zool., Bologna.
Harengula latulus Cuvier and Valenciennes 1847, p. 280, pl. 595 (?Caen, ?Dieppe). Types: Museum Nat. Hist. Paris; a cotype (syntype) formerly Paris Mus. no. 3236, now Stanford N.H.M. no. 32769. (*nec Clupea latulus* Cuvier 1829.)
Harengula clupeola Cuvier and Valenciennes 1847, p. 289 (Martinique). Types: Museum Nat. Hist. Paris (2 specimens?).
?Alosa bishopi Müller and Troschel 1848, p. 675 (Barbados). Type: Probably in Berlin.

(For complete citations see Bibliography; for discussion see Nomenclatural Notes.)

(Figs. 2,3,9,10,11,14,15,16, and 17.)

Depth in length 2.95 - 3.55 (3.25)[11]; head in length 3.3 - 3.7 (3.5); head depth in length 4.55 - 5.25 (5.0); eye in length 10.0 - 11.4 (10.6); eye in head 2.9 - 3.2 (3.0); opercle depth in head 1.65 - 1.9 (1.8); gill-cover depth in head 1.4 - 1.7 (1.55); head depth in head 1.3 - 1.5 (1.4); eye depth in head depth 2.0 - 2.3 (2.15); opercle depth in head depth 1.2 - 1.4 (1.3); gill-cover depth in head depth 1.0 - 1.2 (1.1); head in depth 1.0 - 1.2 (1.1); head depth in depth 1.4 - 1.7 (1.55); eye in depth 2.9 - 3.55 (3.3); eye to preopercle in eye 1.0 - 1.2 (1.1); snout in eye 1.15 - 1.4 (1.3).

Occiput depth in length 3.6 - 4.3 (4.0); anterior body angle 28° - 37° (33.15°); posterior body angle 25° - 40° (33.5°); ventral body angle 130° - 150° (138.4°). Gill-rakers below the angle of the first arch 29 - 34 (31.8). Ventral scutes 15 - 18 + 13 - 16 = 29 - 32 (30.55). Dorsal fin-rays 17 - 20 (18.4); anal 17 - 19 (18.3). Scales 38 - 42 longitudinal, 11½ transverse count; heavier than those of *H. humeralis*, dorsal and sometimes lateral scales crenulated, the free surfaces bearing prominent, radiating ridges, with fenestrations between the ridges. First ventrad prepectoral scales with several long, flat, fingerlike projections from the free edges. Midlateral scales from the midsection with 2 - 3 (3) parallel and continuous transverse grooves. The grooves are fewer (1 - 2) in scales cephalad and ventrad, and more numerous (3 - 5) in scales dorsad and caudad. Dorsal and caudal fins lightly pigmented, never blackish; pectorals, ventrals, and anal pale in preservative. Lips and dorsum dusky. Humeral spot usually visible; evidence of lateral markings above the midline.

A slender, silvery fish, with a moderate, rather deep head, and a small eye.

Forty-six specimens, 67.5 - 118.0 mm. (88.6 mm.) in standard length, were

[11] Arithmetic mean.

Fig. 12. *Harengula majorina*. Upper: a paratype, Acad. Coll. no. 10780 (Province of São Paulo, Brazil), in alcohol; lower: holotype, Stanford Coll. no. 31742 (Santos, Brazil), formaldehyde-fixed, alcohol preserved. Natural size.

Fig. 13. *Harengula pensacolae* from Sanibel, Fla. Upper: large-eyed; lower: small-eyed specimen. Formaldehyde-fixed. Natural size. Note: depth variation shown is inconstant for series.

used for these measurements, from Panama; Glover Reef, British Honduras; St. Lucia, B.W.I.; Porto Rico; Jamaica; Cuba; Garden Key, Dry Tortugas, Fla. (1 specimen); and the Bahamas.

HARENGULA MAJORINA SP. NOV.

?Harengula humeralis Cuvier and Valenciennes 1847, p. 293 (Guadeloupe, Rio de Janeiro to the Antilles, Brazil, Bahia, Surinam, ?San Domingo). Types: Museum Nat. Hist. Paris. (*nec Clupea humeralis* Cuvier 1829.)
(For complete citations see Bibliography;
for discussion see Nomenclatural Notes.)

(Figs. 9, 12, and 17.)

Depth in length 2.55 - 3.0 (2.8)[12], Brazil (2.7)[13]; head in length 3.35 - 3.9 (3.6), Brazil (3.75); head depth in length 4.3 - 5.0 (4.65), Brazil (4.7); eye in length 9.9 - 10.7 (10.3), Brazil (10.25); eye in head 2.75 - 3.0 (2.85), Brazil (2.75); opercle depth in head 1.5 - 1.7 (1.6), Brazil (1.55); gill-cover depth in head 1.3 - 1.5 (1.4), Brazil (1.35); head depth in head 1.2 - 1.4 (1.3), Brazil (1.25); eye depth in head depth 2.1 - 2.4 (2.2), Brazil (2.15); opercle depth in head depth 1.15 - 1.3 (1.25), Brazil (1.25); gill-cover depth in head depth 1.05 - 1.15 (1.1), Brazil (1.05); head in depth 1.2 - 1.5 (1.3), Brazil (1.35); head depth in depth 1.5 - 1.8 (1.65), Brazil (1.7); eye in depth 3.4 - 4.05 (3.65), Brazil (3.8); eye to preopercle in eye 1.0 - 1.15 (1.05), Brazil (1.05); snout in eye 1.3 - 1.45 (1.35), Brazil (1.4).

Occiput depth in length 3.4 - 3.7 (3.55), Brazil (3.5); anterior body angle 36° - 43° (39.45°), Brazil (40.65°); posterior body angle 34° - 46° (39.1°), Brazil (41.0°); ventral body angle 116° - 136° (127.5°), Brazil (124°). Gill-rakers below the angle of the first arch 31 - 36 (33.55), Brazil (32.5). Ventral scutes 15 - 17 + 13 - 16 = 30 - 32 (31.1), Brazil (30.85). Dorsal fin-rays 18 - 19 (18.4), Brazil (18.3); anal 17 - 18 (17.8), Brazil (18). Scales about 40 longitudinal, 11½ transverse count; thicker than those of *H. humeralis*, dorsal and sometimes lateral scales crenulated, the free surfaces bearing prominent, radiating ridges, with fenestrations between the ridges. First ventrad prepectoral scales with many short, sharply pointed projections from the free edges in the larger (Brazil) specimens, somewhat fewer, broader, and flatter in the smaller specimens. Midlateral scales from the midsection with 3 - 5 (4) parallel and continuous transverse grooves. The grooves are fewer (1 - 2) in scales cephalad and ventrad, where they are frequently neither parallel nor continuous, and more numerous (4 - 6) in the scales dorsad and caudad. Tips of longest rays of upper caudal lobe blackish in formaldehyde-fixed specimens; dorsal and rest of caudal lightly pigmented; pectorals, ventrals, and anal pale in preservative. Lips and dorsum dusky. Humeral spot present; evidence of lateral markings above midline.

A deep-bodied, silvery fish, with a very convex ventral outline, especially notable in larger specimens; short, deep head, and moderately large eye.

Thirteen specimens, 61.3 - 144.5 mm. (100.1 mm.), Brazil 130.2 - 144.5 mm. (134.6 mm.) in standard length, were used for these measurements, from "West

[12] Arithmetic mean.

[13] The six largest specimens in this series are from Brazil, and from these the holotype was selected. Their mean is given for each character to show the direction of their slight variation from the mean of the whole group.

Indies"; St. Lucia, B.W.I.; Santos and Province of São Paulo, Brazil. The minimum used (61.3 mm.) is very low, as this species grows to large size, but was necessitated by the small number of specimens at hand. The holotype of *H. majorina* is a specimen 135.0 mm. in standard length, Stanford N.H.M. no. 31742, (fig. 12) collected at Santos, Brazil, in 1934 by Dr. A. W. Herre. Paratypes are Stanford N.H.M. no. 32768, Calif. Acad. nos. 10780 (fig. 12), 5583, 5584, and 5585. (majorinus, of the larger sort, of a larger form.)

Although *H. majorina* forms a reasonably homogeneous species, the series is unsatisfactory for several reasons besides its limited number of specimens. It is discontinuous, with a wide gap between the small and large size-classes; the small specimens are from the Caribbean, the large ones from Brazil. Further, is either group representative (as to size, for instance) of the fishes of this species from their respective localities? Most of the variations from the means indicated could be due to size alone. A disturbing factor, however, is the slightly higher gill-raker counts found in the smaller specimens. Eventually it may become necessary to make at least a subspecific separation of these groups.

In a statistical comparison of *H. majorina* with the other three West Indian species (table 3), because of the small series the standard error becomes correspondingly greater, thus increasing the probability that the differences are due to sampling errors only. Nevertheless, only the *pensacolae-majorina* pairings show a majority of statistically insignificant differences; and even here the following show highly significant differences: gill-raker and ventral scute counts, and the opercle and gill-cover depths in head; with the proportions head depth in head and depth at occiput in length moderately significant. Also, there are slight but definite differences in the scale characters.

HARENGULA PENSACOLAE GOODE AND BEAN 1880

Harengula pensacolae Goode and Bean 1880, p. 152 (Pensacola). Types: U.S.N.M. no. 22831 (2 specimens).
(For complete citation see Bibliography; for discussion see Nomenclatural Notes.)

(Figs. 2,4,5,9,10,11, and 13.)

Depth in length 2.55 - 3.15 (2.85)[14]; head in length 2.45 - 3.9 (3.6); head depth in length 4.5 - 5.15 (4.75); eye in length 9.0 - 11.3 (10.2); eye in head 2.5 - 3.1 (2.85); opercle depth in head 1.5 - 1.9 (1.7); gill-cover depth in head 1.3 - 1.6 (1.5); head depth in head 1.2 - 1.4 (1.35); eye depth in head depth 1.95 - 2.5 (2.15); opercle depth in head depth 1.2 - 1.35 (1.3); gill-cover depth in head depth 1.0 - 1.2 (1.1); head in depth 1.1 - 1.5 (1.25); head depth in depth 1.45 - 1.85 (1.65); eye in depth 3.2 - 3.95 (3.55); eye to preopercle in eye 1.0 - 1.2 (1.1); snout in eye 1.2 - 1.5 (1.3).

Occiput depth in length 3.3 - 3.8 (3.6); anterior body angle 33° - 44° (38.35°); posterior body angle 32° - 44° (36.9°); ventral body angle 118° - 142° (130.15°). Gill-rakers below the angle of the first arch 35 - 40 (37.05). Ventral scutes 15 - 17 + 13 - 15 = 28 - 31 (29.8). Dorsal fin-rays 17 - 19 (18.4); anal 17 - 19 (17.95). Scales 38 - 42 longitudinal, 11½ transverse count; thicker than those of *H. humeralis*, dorsal and sometimes lateral scales sharply crenulated, the free surfaces bearing prominent, radiating ridges, with fenestrations between the ridges. First ventrad prepectoral scales bear several long, flat, fingerlike

[14] Arithmetic mean.

Table 6. Constants of the frequency distributions and comparison of differences between means for *Harengula pensacolae* series in alcohol (pen) and from Sanibel, Fla., in formaldehyde (san). See table 3 for explanation of symbols.

	N	CI	M	s	Pairs	D	SE_D	RD	p
Depth/Length									
pen	63	.05	2.87	.122	pen-san	.041	.025	1.67	.1
san	76	.05	2.911	.167					
Eye/Length									
pen	63	.1	10.195	.414	pen-san	.415	.088	4.7	.001-
san	76	.2	10.61	.62					
Head Depth/Length									
pen	63	.05	4.755	.134	pen-san	.042	.026	1.59	.12
san	76	.05	4.797	.178					
Head/Depth									
pen	63	.025	1.241	.082	pen-san	.002	.015	.16	.9
san	75	.025	1.244	.09					
Eye/Depth									
pen	63	.05	3.565	.213	pen-san	.102	.043	2.35	.02-
san	76	.05	3.667	.297					
Head Depth/Depth									
pen	63	.025	1.659	.078	pen-san	.011	.014	.80	.43
san	76	.025	1.647	.100					
Head Depth/Head									
pen	63	.02	1.340	.053	pen-san	.014	.009	1.58	.12
san	76	.02	1.326	.048					
Opercle/Head									
pen	62	.025	1.715	.066	pen-san	.012	.011	1.1	.27
san	76	.025	1.727	.061					
Gill-Cover/Head									
pen	62	.02	1.473	.060	pen-san	.023	.009	2.49	.02-
san	76	.02	1.496	.049					
Eye Depth/Head Depth									
pen	63	.025	2.139	.085	pen-san	.076	.020	3.82	.001-
san	76	.025	2.215	.144					
Depth at Occiput/Length									
pen	63	.025	3.605	.100	pen-san	.095	.020	4.74	.001-
san	76	.025	3.701	.137					
Anterior Body Angle									
pen	63	1.0	38.35	2.385	pen-san	1.125	.415	2.71	.01-
san	76	1.0	39.475	2.485					
Posterior Body Angle									
pen	63	1.0	36.9	2.95	pen-san	.055	.499	.11	.9
san	76	1.0	36.845	2.89					
Ventral Body Angle									
pen	63	1.0	130.13	5.245	pen-san	.25	.889	.28	.8
san	76	1.0	130.38	5.87					
Gill-Raker Count									
pen	63	1.0	37.03	1.17	pen-san	.175	.208	.84	.4
san	76	1.0	36.885	3.9					
Ventral Scute Count									
pen	62	1.0	29.79	.678	pen-san	.105	.348	.30	.8
san	76	1.0	29.685	.595					
	N	CI	M	s	Pairs	D	SE_D	RD	p

projections at the free edges. Midlateral scales from the midsection with 2 - 4 (3.7) parallel and continuous transverse grooves. The grooves are fewer (1 - 3) in the scales cephalad and ventrad, and more numerous (3 - 7) in the scales dorsad and caudad. Dorsal and caudal fins lightly pigmented, never blackish; pectorals, ventrals, and anal pale in preservative. Lips and dorsum dusky. Humeral spot usually visible; evidence of lateral markings above the midline.

A deep-bodied, short-headed, silvery fish, the eye-size quite variable.

Sixty-three specimens, in alcohol, 64.7 - 115.2 mm. (79.8 mm.) in standard length, were used for these measurements, from Key West, the Florida Keys, Cape Sable, Egmont Key, Cedar Keys, and Pensacola, Fla.; and Galveston, Texas.

Over 2,000 specimens, mostly immature, and mostly from Yucatan, arrived from Dr. Hubbs, for use in another study. However, a series in three lots from Progreso, 64.0 - 110.0 mm. in standard length, in alcohol, were measured and found to fall well within the limits for the species in all counts and proportions, and very close to the mean in most. The eye averaged a little larger. There was a distinct tendency toward greater body depth, helping to confirm the suspicion that, in this species, body depth increases in specimens to the westward (counterclockwise) around the Gulf of Mexico.

Seventy-six specimens, 65.6 - 107 mm. (84.6 mm.) in standard length, from Sanibel, Florida, formaldehyde-fixed, were compared statistically with the 63 specimens of *H. pensacolae* in alcohol (table 6). Highly significant differences are shown in proportions involving the eye and the occiput depth in length; with moderately significant differences in the gill-cover depth in head and the anterior body angle. Except for the first, preservative may play an important part in these differences. The eye differences demand another explanation, as the eye measurements were taken from the bony orbit. The Sanibel series can be separated "by eye" into large- and small-eyed groups (fig. 13), which, however, show no highly significant differences in other characters. The eye variation is not sexual, as testes were found in specimens from each group. The large-eyed group is definitely closer to the *H. pensacolae* alcohol series. The solution of these problems awaits further study.

THE *HARENGULA* OF THE PACIFIC COAST OF AMERICA[15]

The following is not a West Indian form, and the material is totally inadequate for analysis; but since the measurements were taken by the methods used for the West Indian species, it seems worthwhile to include the results.

HARENGULA THRISSINA (JORDAN AND GILBERT) 1882

Clupea thrissina Jordan and Gilbert 1882b, p. 353 (Cape San Lucas). Types: U.S.N.M. nos. 6388, 2524, and 6339 ("several specimens").
(For complete citation see Bibliography.)

(Figs. 9 and 14.)

Depth in length 3.3 - 3.65 (3.45)[16]; head in length 3.45 - 3.65 (3.6); head depth in length 4.9 - 5.2 (5.05); eye in length 10.3 - 11.1 (10.7); eye in

[15] The little-known *H. peruana* is discussed on p. 51.
[16] Arithmetic mean.

head 2.9 - 3.1 (3.0); opercle depth in head 1.8 - 1.85 (1.8); gill-cover depth in head 1.55 - 1.6 (1.55); head depth in head 1.4 - 1.45 (1.4); eye depth in head depth 2.1 - 2.15 (2.1); opercle depth in head depth 1.25 - 1.3 (1.25); gill-cover depth in head depth 1.1 - 1.15 (1.1); head in depth 1.0 - 1.1 (1.05); head depth in depth 1.45 - 1.5 (1.5); eye in depth 3.05 - 3.2 (3.1); eye to preopercle in eye 1.05 - 1.1 (1.1); snout in eye 1.25 - 1.3 (1.25).

Occiput depth in length 3.85 - 4.3 (4.1); anterior body angle 28° - 32° (29.65°); posterior body angle 28° - 35° (32°); ventral body angle 133° - 147° (141.35°). Gill-rakers below the angle of the first arch 29 - 30 (29.35). Ventral scutes 16 - 17 + 12 - 14 = 29 - 30 (29.65). Dorsal fin-rays 18 - 19 (18.5); anal 15 - 16 (15.65). Scales 39 - 40 longitudinal, 12½ - 13½ transverse count; rather thin and glassy; dorsal, lateral and peduncular scales more or less crenulated, the radiating ridges on the free surfaces very low if present, with no fenestrations between ridges. First ventrad prepectoral scales ragged, but entire, with no fingerlike projections. Midlateral scales from the midsection with about 3 continuous and parallel transverse grooves. Dorsal and caudal fins lightly pigmented; pectorals, ventrals, and anal pale in preservative. Lips and dorsum dusky. Humeral spot prominent; lateral markings above midline not evident.

Three specimens, in alcohol, 72.2, 75.5, and 95.7 mm. in standard length, were used for these measurements, from mouth of Rio Mulege, Concepcion Bay, Gulf of California; and "West Coast Mexico."

From the above, *H. thrissina* would seem to be rather more slender than is *H. clupeola*, with which it is frequently compared (fig. 14), and which it resembles closely in other proportions. However, the gill-raker and ventral scute counts seem lower, there is much less sculpturing on the scales, and the ventrad prepectoral scales are without projections at the free edges. Furthermore, the anal fin has fewer rays, and there are one to two more transverse rows of scales than any West Indian *Harengula* possesses.

NOMENCLATURAL NOTES

Due to the great confusion that has reigned in regard to the application of both the generic and the specific names of these Clupeids, it has been considered best to quote in the preceding synonymies only the original references to names proposed as new, with the exception of those of Valenciennes. The original descriptions are all old and faulty, and frequently contain references to few or none of the diagnostic characters now used. In order to clear up the application of these names, a chronological summary for the genus and for each species is given below, with reasons for the present placement of the name. Certain of the original descriptions which are not easily obtained are quoted in part or in full. Complete citations are given in the Bibliography.

GENUS HARENGULA. *Harengula latulus* Cuvier and Valenciennes (*nec Clupea latulus* Cuvier 1829) 1847, p. 280, pl. 595, was made genotype by original designation (pp. 277, 281). According to Valenciennes, "La Harengule Blanquette" was abundant in the North Sea and along the coasts of Picardy and Normandy in France. Among others, Marcotte (1860), Moreau (1881, 1892), Sauvage (1888), Malard (1890), and Gadeau de Kerville (1897), in their descriptions, almost unanimously attest to its abundance off the coast of France. Cligny (1909) points to their evident dependence upon predecessors rather than specimens for their descrip-

tions, and maintains that these refer to young herrings and sprats. He feels there is little possibility that the species will be found, for he has seen none among thousands of specimens from the localities, nor has it been reported by any British authority on English Channel fishes; therefore he proposes that the name be suppressed. LeDanois (1913), in rebuttal, merely reexamines one of the types (p. 41, and fig. 54). However, Joubin and LeDanois (1924) omit the species from their *Poissons Osseux* of France. Günther (1868, p. 422) gives *Clupea latula* specific rank (with *Harengula latulus* Cuvier and Valenciennes alone in the synonymy, and no mention of Cuvier's species), but suggests that it "may prove identical with *Cl. humeralis*"; while Regan (1917b, p. 388) definitely synonymizes it with *Harengula macrophthalma*, with the footnote: "Valenciennes describes *H. latula* as a European species; it is probable that this is a mistake, although it is not impossible that this species may cross the Atlantic." Thus we find no evidence that any ichthyologist since Valenciennes has described *Harengula latulus* from recent specimens, and two authors who suggest that it is a West Indian form. Finally, Chabanaud (communication to Dr. Myers, dated Dec. 7, 1937) writes: "J'estime, à priori, peu vraisemblable la présence, sur les côtes européenes, d'un Clupéidé américain de la dimension de cet *Harengula latulus*. Les erreurs d'étiquetage fourmillent dans les collections de l'époque de Valenciennes et il est prudent de s'en méfier!" He also says: "La collection possède, étiques de la main de Valenciennes, un spécimen 'originaire de Caen' et, dans un autre local, un dizaine d'individus *réputés* provenir de Dieppe. Tous sont dits être désignés, dans la région, sous le nom de 'blanquette.' Je n'ai pas pris le temps de les examiner en détail, mais je ne saurais douter que tous ces poissons appartiennent à la même espèce."

A cotype with the following unattached tag: "*Harengula latulus* C&V Blanquette de Dieppe par M. Valenciennes 1827 no. 3236 Coll. Mus." has been presented to the Stanford Natural History Museum by the Paris Museum through the great kindness of Prof. Pellegrin and Dr. Chabanaud. The latter writes that the specimen was entered in the collection in 1837. Since Dr. Chabanaud (above) believes the "Caen" and "Dieppe" specimens to be identical, and both he and Dr. Pellegrin refer to this specimen as a type, and since *H. latulus* has never been redescribed from the types, except for the short notes of LeDanois, it seems useful to give the results of my examination briefly.

The cotype (syntype), now Stanford N.H.M. no. 32769 (fig. 15), is in good condition, considering its age. The left side has been dissected away, by Valenciennes, according to Dr. Chabanaud, to expose the vertebrae. The tip of the tail is missing. The standard length is 74.2 mm. The fish resembles *Harengula clupeola* in all ways, and falls well within the limits for that species in all characters. Considering its small size and slightly damaged condition, its approximation to the mean for that species (given in parentheses) in all proportions and counts is remarkable: depth in length 3.54 (3.25); head in length 3.57 (3.5); head depth in length 4.95 (5.0); eye in length 10.6 (10.6); eye in head 2.97 (3.0); opercle depth in head 1.81 (1.8); gill-cover depth in head 1.6 (1.55); head depth in head 1.39 (1.4); eye depth in head depth 2.145 (2.15); head in depth 1.01 (1.1); head depth in depth 1.4 (1.55); eye in depth 3.0 (3.3); occiput depth in length 4.125 (4.0); anterior body angle 32° (33.15°); posterior body angle 35° (33.5°); ventral body angle 137° (138.4°); gill-raker count 30 (31.8); posterior ventral scutes (ant. damaged) 16 (13 - 16), original description totals 30 (30.55); midlateral scales from midsection with 2 - 3 parallel and continuous transverse grooves (3), original description 2 - 3. Vertebrae 43 (Regan 1917b, 43 - 44 for

H. macrophthalma, now synonymized with *H. clupeola*), original description 44. There is nothing about the specimen to suggest that it is not *H. clupeola*, and it must therefore be placed in the synonymy of that species. This does not, of course, affect the validity of the generic name.

Clupea latulus Cuvier 1829, p. 318 (1843, p. 273), "La Blanquette, Breitling des Allemands, White-Bite des Anglais," is briefly described, with no indication that Cuvier had specimens at hand. He cites only "Schonefeld. p. 41," unquestionably Schonevelde's (1624) description "De Latulo," here quoted in full:

> In Ekrefordensi sinu ad mare Balthicum sub vernum tempus pisciculus capitur sui generis *Bredling* dictus, (unde latulum ego verti) qui ut ex mari proxime Harengum sequitur gregatim, ita colore, exilibus squamis, facileque deciduis, & pinnarum numero illi similis est, verum sex digitorum longitudinem raro superat, pro mole minore est capite, magis compresso, latioreque corpore ac ventre, asperioribus squamis falcato, quam ille, dorso in acumen desinente. Coquitur ex aqua cum sale & lardo conciso, conditur muria ut plurimum, & infumatur, atque ita seipso melior fit, & cum Sardis vel *Sprot* Anglorum facile certat. Capitur, ut dixi, seorsim, & inter Harengos, à quibus facile discernitur.
>
> Etsi autem pisciculus hic cum plerisque aliis lineam asperam sub ventre communem habet, ab Agono tamen (vel Chalcide) Rondeletii discrepat, quod hic lacubus dulcibus & fluviis communis sit, ab Alausa quod ea major, & spinis molestior sit quam latulus, ab Apua Phalerica quod minus haec sit pinguis.

Clupea schoneveldii Krøyer 1846-1849, p. 193, is described, obviously from specimens at hand, as a deep-bodied herring from the Baltic. Schonevelde's *latulus* is placed in synonymy, with an extensive discussion of the reasons therefor. He also states (p. 194): "Jeg skulde derfor have optaget Schoneveldes Artsnavn, *Latulus*, som ret betegnende for Arten, dersom dette ikke allerede af Cuvier (Regne anim. 2ème éd. II, 318) var blevøn anvendt paa en anden Art," and a footnote: "Cuvier antager vel sin *Cl. latulus* som identisk baade med Englaendernes *Whitebait* og med Schoneveldes *Latulus*....Og efter Yarrell's Beskrivelse af *Whitebait'en* stemmer den ligesaalidt med denne, og Y. tager heller intet Hensyn til Cuviers Artsnavn, men kalder denne engelske Fisk *Cl. alba*" Yarrell 1829, a species long since placed in synonymy as the young of herrings and sprats (Day, 1879, 1880-1884, and succeeding authors), despite the fact that Valenciennes (1847, p. 340) was sufficiently impressed to make for it a new genus, *Rogenia*. Collet (1875, p. 193) refers to: "Den Varietet af *C. sprattus*, hvor Legemshøjden er betydeligt større, end normalt (*C. shoneveldi*, Kr.), har jeg flere Gange fundet blandt Hovedarten ved Christiania," but notes that "Overgange mellem begge Former ere ikke sjeldne." Recent northern authors, including Lilljeborg (1891) and Smitt (1895), place *C. schoneveldii* in synonymy with *C. sprattus*. Günther (1868, p. 416) synonymizes *C. latulus* Cuvier with the young of *C. harengus*.

Valenciennes (p. 285), without direct reference to *Clupea latulus* Cuvier, cites Schonevelde's "latulus" ("Breitling") as descriptive of "*Harengula sprattus* nob.", and, as stated above, makes a new genus for the "Whitebait." This leaves only "La Blanquette" of the three common names Cuvier uses, and this Valenciennes applies to "*Harengula latulus* nob." A point might be made of Valenciennes' habit of adding "nob." to well-known species when placing them in new genera, but since

Cuvier's species has already disappeared, and Valenciennes' species, after long use, is about to disappear into synonymy, it hardly seems worth while.

There is no doubt that the genotype of *Harengula* is *Harengula latulus* of Valenciennes 1847, and not the *Clupea latulus* of Cuvier 1829, irrespective of whether or not Valenciennes' and Cuvier's species were meant to be identical. Valenciennes describes both the genus and the species as new, with no reference whatever to Cuvier's 1829 description. Valenciennes refers to *H. latulus* as the sole type of the genus on p. 281, even if his reference on p. 277 is somewhat ambiguous. Gill (1861, p. 36), Jordan and Gilbert (1882a, p. 268), and Jordan (1919, p. 231) definitely designate *H. latulus* as the genotype of *Harengula*. In fact, no one up to the present time seems ever to have considered that *latulus* of 1847 might have been the same as *latulus* of 1829; indeed, no author, except Krøyer, Günther, Schinz, and Bonaparte, seems even to have mentioned the 1829 reference. Valenciennes was, of course, the sole author of the 1847 description, since Cuvier had died in 1832, and even though Cuvier's name continued to appear as co-author of the *Histoire*. It is naturally to be supposed that Valenciennes knew of the 1829 reference, and he probably believed the specimens he was describing were identical with part, at least, of what Cuvier had called *Clupea latulus*, but in no place is there any direct evidence of this. I therefore recognize only Valenciennes' *Harengula latulus* of 1847 as the genotype of *Harengula*, and exclude the extremely doubtful 1829 name from any consideration in this regard.

Valenciennes' specimens represent a species of the genus which Regan and others have called *Harengula*, and the name is therefore saved for the group to which it has become attached through long usage. The genus is unknown in the eastern Atlantic. Valenciennes' types must have been erroneously labelled, as suggested by Dr. Chabanaud (above). Cuvier's *Clupea latulus* is based on Schonevelde's (1624) description "De Latulo" from the Baltic, and is certainly, therefore, a synonym of either *C. harengus* or *C. sprattus* of Europe.

HARENGULA HUMERALIS (CUVIER) 1829. *Harengula humeralis* has practically always been cited as originally described by Cuvier and Valenciennes (1847, p. 293). All authors, except Valenciennes (p. 295), Castelnau (1855), and Poey (1866) appear to have neglected *Clupea humeralis* Cuvier 1829 (p. 318, footnote 2; "Disciples' Edition," 1843, p. 274, footnote 1), which is based entirely on Duhamel's pl. 31, fig. 4 (my fig. 16), from Guadeloupe, though Cuvier calls it "La Sardine de la Martinique." Valenciennes (p. 294) also refers to Duhamel's figure, as well as to his description of the "Sardine des Antilles" p. 548, as representing "sans contredit" his *H. humeralis*. Now this Cuvier and Valenciennes description of *H. humeralis*, the notes received from Dr. Chabanaud on the types, as well as a lateral scale in my possession from one of the types (see later), prove that the actual specimens Valenciennes had were *not* the same as Duhamel's fig. 4 and description. It is evident that *H. humeralis* must date from Cuvier 1829, and that its placement must depend entirely on Duhamel, without reference to Valenciennes' specimens in the Paris Museum. (*H. humeralis* Cuvier and Valenciennes is possibly my *H. majorina* from Brazil and the southern Antilles.) The Duhamel description, here given in full, is entitled "De la Sardine des Antilles, figure 4," and was written, not by him, but by a M. Barbotteau "Conseiller au Conseil Supérieur" of the Colony of Guadeloupe, who also made the original drawing for the figure.

Je passe à la description de notre Sardine proprement dite. Son bec est plus pointu que celui du Cailleu ordinaire; sa tête est plus

allongée; son palais & ses mâchoires sont armés de petites dents presqu'imperceptibles, & dont on ne s'apperçoit guere que parce qu'elles résistent fortement au toucher. Il a le dessus de la tête diaphane; son cerveau paroît à travers; son oeil est assez grand, la prunelle est noire, l'iris est argenté & couronné d'un croissant d'un très-beau verd, qui disparoît après la mort de l'animal; ses ouies, au nombre de quatre, sont rangées & colorées de même que celles du Cailleu; elles ont la même forme, & servent aux mêmes usages. Une petite portion d'ouie de chaque côté paroît près de l'oeil adaptée à l'opercule, qui est partagé en deux, & composé de quatre lames argentées. C'est une vigoureuse défense que l'Auteur de la Nature semble avoir donnée aux Poissons pour mettre à l'abri leur poumons, leur coeur, & les parties les plus essentielles de leur organisation interne.

Le dos de la Sardine, nuancé de mille couleurs diverses semblables à celles d'un bel arc-en-ciel, perd beaucoup de son éclat après la mort du Poisson. De toutes ces couleurs changeantes, il ne reste qu'un bleu foncé. Un aileron unique garni de 17 à 18 rayons, joints par une membrane, s'éleve au milieu du dos; cet aileron dorsal a l'extrêmité des rayons noire; le reste est coloré d'un blanc sale: les nageoires pectorales & ventrales sont très-blanches; les premieres ont 14 rayons, les secondes 8; ces rayons sont joints & liés par une membrane très-fine & très-déliée; l'aileron de l'anus a 18 à 20 rayons, joints par une semblable membrane; la couleur blanche seule y domine: l'aileron de la queue est fourchu, & coloré de jaune vers le centre au point de réunion; la couleur blanchâtre regne sur les côtés, & la noire aux extrêmités des rayons, qui sont au nombre de 25, épais & unis ensemble; les écailles sont très-grandes, & fort bien rangées; elles sont moins serrées que celles des Cailleux.

Le ventre de la Sardine, de couleur argentée, se termine par 28 petites pointes très-visibles & très-sensibles. Ce Poisson a depuis le sommet du dos jusqu'au bas du ventre 10 à 11 raies ou lignes latérales, dont celles du milieu sont de la couleur d'une paille jaunissante; son corps est plus gros & plus relevé vers le milieu; sa structure intérieure est généralement semblable à celle du Cailleu; son abdomen & ses moustaches sont terminés en dents de scie: *Abdominis carina serrata, & mystaces serrati.* Sa chair est blanche & moins agréable au goût que celle des Cailleux; elle est sujette à incommoder, elle empoisonne même; elle occasionne des fievres, & donne souvent la mort, quand le Poisson est pris au-dessus des fonds dits *cuivrés*, ou qu'il a mangé de cette espece de Brûlans qu'on nomme des *Galeres.*

Il habite les mêmes lieux que le Cailleu ordinaire; il se nourrit & fraye de même: on les pêche à l'épervier; on en prend par fois dans les saines avec de plus gros Poissons.

Sa longueur totale est de 5 à 6 pouces depuis la naissance du museau jusqu'à l'extrêmité de la queue: sa largeur est de 16 à 17 lignes.

Ce Poisson pourroit être désigné sous cette phrase Ichthyologique; *Clupea, Alosa minor, Sardina Caribaearum propriè dicta.*

This remarkable description, made by a keen observer, actually in the field, is unmistakably of the *Harengula humeralis* (Cuvier) of the present study, and contains by far the best description of the life-colors.

Harengula maculosa Cuvier and Valenciennes 1847 (p. 292) (Martinique), separated by Valenciennes from his *H. clupeola* by the more pointed snout, the greater number of transverse grooves in the scales, the 27 ventral scutes, and the larger size, must now be placed in the synonymy of *H. humeralis* (Cuvier). Dr. Chabanaud reports that he cannot find the types, and believes them lost.

Alosa apicalis Müller and Troschel 1848, p. 675 (Barbados) is also clearly *H. humeralis*. The transverse scale count given is doubtless erroneous, as none of the West Indian species of *Harengula* have so low a count. I have been unable to locate the type; it is probably in Berlin. The description follows:

> 79) Alosa apicalis *Müll. et Tr.* nov. spec. Red Ear Pilchard. D. 18; A. 17. The lower jaw surpasses the upper in length, the maxillary reaches the first third of the eye, and the diameter of that organ is larger than half the size of the head. The scales are large, forming nine rows on each side of the body; they are silvery and each scale is marked on the belly with a copper coloured spot. The point of the snout above and beneath is black, on the front there is a small black longitudinal band, and over each eye a black spot. The point of the dorsal fin and the posterior edge of the forked caudal fin are black. The ventrals are attached under the middle of the dorsal fin.

Harengula sardina Poey 1860, p. 310 (Cuba) has 25 ventral scutes; the scales are thin, entire, and fall out easily; there are dark markings on the dorsal and caudal. Poey repeatedly states (1860, p. 310; 1865, p. 190; 1868, p. 418; 1876, p. 147) that his species is either near or the same as Valenciennes' *H. humeralis*, but after having reviewed the Cuvier and Valenciennes types he definitely asserts (1866, p. 378) that *H. sardina* is not precisely the *humeralis* of Valenciennes. In 1876, p. 147, he shows that he had read Cuvier's footnote, for he says that his fish is probably the same as *Clupea humeralis* Cuvier, then spoils it by adding "descrita por Valenciennes in C. et V. xx, p. 293, con el nombre de *Harengula humeralis*." Small wonder that he was puzzled. The types, Poey's no. 40, U.S.N.M. no. 4794, entered in the U.S.N.M. catalog between the years 1861 and 1872 (2 specimens), were examined for me by Dr. Leonard P. Schultz, who reports: "They are in fair condition, except for damaged fins. One specimen, female, is 130 mm. standard length (total length probably around 170 mm.) and the other is 101 mm. The latter has a total length of 130 mm." Cotypes, evidently, were located at the Museum of Comparative Zoology: M.C.Z. tag no. 17868 attached (1 specimen), and M.C.Z. tag no. 17736 unattached (2 specimens). Dr. William C. Schroeder examined these for me and found the scales thin and glassy; evidence that the tip of the dorsal had been dusky; ventral scute counts of 15 - 16 + 12 = 27 - 28; and gill-raker counts below the angle of the first arch of 24, 25, and 29. The standard lengths were 101, 118, and 127 mm.

Harengula jaguana Poey 1865 p. 189 (Cuba) is placed with *H. humeralis* with reservations, for although Poey counts 25 ventral scutes, he insists, not only in the original description, but in 1868 and 1876, that the scales are more "firmes," the body shorter, and the pectoral longer than in his *H. sardina*. I have been unable to locate the types (Poey's no. 580).

Harengula callolepis Goode 1880 p. 152 (Bermuda) is probably *H. humeralis*. The description is poor, but includes slender body and small head depth; smooth scales, with the cephalad lateral scales with very irregular transverse grooves, and the caudad laterals with many transverse grooves; few gill-rakers; rather

large eye; and 12 abdominal scutes. But he mentions a transverse scale count of 10½. Dr. Schultz examined the type, U.S.N.M. no. 21243, for me, and reports 30 gill-rakers below the angle of the first arch on the right side, and 29 on the left; ventral scutes 17 + 11 = 28; tip of dorsal possibly blackish (the color is nearly gone); transverse scale count from origin of dorsal 10½, from middle of dorsal 11½. Dorsal 18, anal 19. Dr. Schultz also sent me a lateral scale from the midsection, which shows 5 continuous and parallel transverse grooves, evidence of very low sculpturing on the exposed part of the scale, and no evidence of crenulations at the free edge; and a middorsal scale, notably thin and glassy, with low ridges on the exposed part, and the free margin ragged but entire.

HARENGULA CLUPEOLA (CUVIER) 1829. Undoubtedly the first published description of this species is the account of the "Petit Cailleu" of Duhamel 1776 (p. 546, pl. 31, fig. 2) from Guadeloupe. Duhamel's plate 31 (see figure 16 of the present revision) shows three Clupeids. Cuvier (1829, p. 320, footnote 2; 1843, p. 276, footnote 1) places Duhamel's figure 3 ("Le Cailleu-Tassart") correctly as *Megalops oglina* of Le Sueur (1818, p. 359), which is now our well-known hickory-shad, *Opisthonema oglinum*. In the same work, Cuvier (1829, p. 318, footnote 2; 1843, p. 274, footnote 1) also names as new *Clupea humeralis*, based on Duhamel's "Sardine des Antilles" (pl. 31, fig. 4), although Cuvier mistakenly refers to it as "Sardine de la Martinique." Finally, in the same footnote, Cuvier intends to name as *C. clupeola* the remaining figure of Duhamel's plate 31 ("Le Petit Cailleu"), but unfortunately gives its name only as "Cailleu," and refers to figure 3 (which is of "Le Cailleu-Tassart," *Opisthonema oglinum*) instead of figure 2, which he obviously intended. There is no doubt whatsoever that this erroneous figure citation is a *lapsus calami* or a typographical error, despite the fact that the error was continued in the 1843 edition of the *Règne Animal*. Cuvier's *Clupea clupeola* could have been intended only for Duhamel's figure 2, since he had given names for the other two figures.

Duhamel's figure 2, made from a drawing by Barbotteau, is clearly of my *Harengula clupeola*. Body angles, and proportions made from the measurements of the figure, fall within the limits for that species, and vary widely from those for my *H. majorina*, the only species with which it might be confused. The description in Duhamel, "Du petit Cailleu, Sardina Caribearum exilis" (p. 546), is also by Barbotteau, and could well apply. The account, omitting only Barbotteau's interesting observations on its life history and economic importance, follows:

> Sa tête est de diverses couleurs, qui se perdent après sa mort: elle est assez grosse proportionnellement au reste du corps qu'il a fort leste & dégagé. Sa gueule est garnie de chaque côté d'un tissu membraneux qui se replie sur lui-même, quand l'animal la ferme. Il l'étend démesurément comme à la figure 3, & en forme d'un large entonnoir quand il l'ouvre. Son palais & ses deux mâchoires, qui sont à-peu-près égales, sont armés de dents petites, fortes & aiguës. Sa langue est cartilagineuse. Son oeil vif & clair-voyant est composé d'une prunelle très-noire & d'un iris argentin. Une couleur verte & semblable à celle d'une précieuse & transparente émeraude, surmonte par le haut en forme de croissant l'iris, qui, au moment de la mort de l'animal, se colore de quelques teintes de sang.
>
> Ses ouies, au nombre de quatre de chaque côté, sont toutes d'un rouge très-foncé. Elles sont frangées, & partagées en forme de scie ou de peigne. Elles sont rangées & serrées les unes contre les autres,

à-peu-près comme les feuillets d'un livre. Celles qui sont les plus près de la tête, sont plus longues & plus larges. Celles qui en sont les plus éloignées, sont plus petites & plus étroites. Celles du milieu diminuent en conséquence, & augmentent à proportion. Le blanc domine aux opercules des ouies.

Le dos, où regnent le verd & le bleu quand l'animal est vivant, perd beaucoup de son éclat après sa mort. Le verd pour lors disparoît; il ne reste plus qu'un bleu foncé.

L'aileron unique de dessus le dos est formé de 17 à 18 rayons, qui sont réunis par un tissu membraneux. La poitrine est munie de deux nageoires composées de 14 rayons, réunis par une membrane très-fine & très-déliée. Le ventre, qui est blanc, est garni de deux nageoires à 8 rayons chacune, joints & enlacés d'une membrane. Il est armé en-dessous, comme les Sardines, de petites pointes, épines ou piquants presqu'imperceptibles. L'aileron de l'anus a 15 rayons, joints par une membrane. L'aileron de la queue est fourchu; il a en tout 24 à 25 rayons.

Les écailles ne laissent pas d'être grandes pour un si petit Poisson, qui n'a que 2, 3 ou 4 pouces tout au plus de longueur, & 8 à 10 lignes de largeur. Elles sont placées les unes sur les autres, & anticipent à la maniere des tuiles les mieux jointes. On distingue visiblement plusieurs lignes latérales, qui semblent servir aux écailles de points d'appui. L'umbilic, ou l'anus, considéré au microscope, paroît avoir trois ouvertures différentes, comme à presque tous les Poissons.

Ce Poisson n'a point de fiel: sa structure ou son organisation interne est d'ailleurs fort simple. Il a deux ovaires très-gros; les mâles ont une laite ou laitance composée de deux corps très-distincts, souvent irréguliers, & toujours colorés d'un blanc sale. Il a un coeur très-petit & triangulaire, une oreillette vaste & d'une très-grande capacité, deux valvules à l'embouchure de l'oreillette, une aorte où le coeur s'emboîte par la base, un estomach vigoureux, un boyau très-long & très-effilé, 42 vertèbres: je n'ai pu lui découvrir de vessie aérienne: les ouies me semblent lui tenir lieu de poumons: elles ont beaucoup d'élasticité, tant pour inspirer que pour aspirer: l'abdomen est resserré. Les pointes hérissées qui le terminent, lui donnent la forme d'une scie: *Abdominis carina serrata.* Il en est de même de la gorge & des moustaches: *Mystaces serrati.* Linn.

D'après cette anatomie & cette description, il suit que le Cailleu doit être placé dans la classe des Poissons abdominaux, & dans le genre des Clupea, qui est le cent-soixantieme du *Systema Naturae,* 10^{e}. édit. Je le désignerai sous cette phrase Ichthyologique: *Clupea minutissima, Alosa brevissima, Sardina Caribaearum exilis,* Cailleu *dicta.*

Harengula macrophthalma (Ranzani) 1842 p. 320, pl. 23, fig. 1 (see figure 15 of the present study), has always been ascribed to Brazil, and every Brazilian *Harengula* has been called *H. macrophthalma.* (In fact, every West Indian *Harengula* has at some time or other been placed in the synonymy of this species.) It is apparently rare or absent from southern Brazil, at least; the type *may* be Antillean

in origin. In the introduction to the paper, Ranzani says "describam picem maris braziliensis, qui est e genere Clupearum," but nowhere in the description, excerpts from which follow, does he give a locality.

> Caput mediocre; rostrum obtusum; os exiguum, maxillae subaequales; superior munita dentibus minutis, a se invicem distantibus, numero viginti quatuor; maxilla inferior instructa denticulis decem et octo conicis, in utroque latere ejusdem tres primi dentes longiores subsequentibus; pars posterior utriusque maxillae omnino edentula; lingua libera, triangularis, superficie aspera. Oculi in sublimi positi, orbiculares, magni aeque distantes ab apice rostri, et a margine posteriori operculorum branchiarum; opercula ista laevia, e tribus laminis coalita; margo posterior eorundem sinuosus, sinubus parum profundis. Radii branchiostegii octo, externi depressi, laminiformes; branchiae quatuor in utroque latere capitis, pectinatae, arcubus in angulum veluti plicatis. Truncus compressus, altus; margo dorsi obtusiusculus, margo ventris acutus, serrulatus. Lineae lateralis indicium prorsus nullum. Pinna dorsalis mediocris, aeque distans ab apice rostri, et ab apice caudae, margine superiori haud profunde concavo, radiis decem, ac septem firmata. Pinna analis humilis, radiis decem, ac septem constans; horum prior ano proximus est, ultimus a basi pinnae caudalis haud parum distat. Pinna caudalis bifurca. Squamae laterum trunci grandiusculae, profunde imbricatae, margine aliquantum sinuoso, superficie superiori distincta cestulis transversis, nonnihil prominentibus, undulatis, et ad marginem non pertingentibus. Mensurae: longitudo tota pars est 5 Poll., 10 lin.; long. capitis, 1.5; long. trunci, 3.4; long. pinnae caudalis, 1.1; long. radii medii pinnae ejusdem, -.3; long. basis pinnae dorsalis, -.10; long. basis pinnae analis, -.9; altitudo partis anterioris trunci immediate post basim pinnarum ventralium, 1.7; crassities maxima trunci, -.6.

Dr. Hildebrand went through the late Dr. Longley's notes for me, and sent me the following results of Dr. Longley's examination of the type in Bologna (parenthetical notes by Dr. Hildebrand): "Bologna. *Clupea macropthalma* is the species one would expect from knowledge of other collections, a beautifully preserved specimen of the hard-scaled sardine with its dark humeral spot especially clearly on the left side. The bottle does not need to be opened in order to permit an entirely satisfactory determination." A few pages later: "*Clupea macrophtalma* (sic) ex mari brasiliensis. Total length 155±; standard length 123; depth 40; head 34; eye 11.5; postorbital head 12.5 mm. Scutes 17 + 13. The characteristic dark spot under the second scale (?) back of the lower edge of the opercular notch. Gill-rakers 31 or 32, can't be quite sure without injuring fish. The eye possibly from being sunken looks perhaps a little larger than northern (?) fish, but seems little doubt it is same. Is largest specimen I have seen from Brazil."

Data from Ranzani's description and plate, from Dr. Longley's measurements, and from the photograph (fig. 15) of the type sent me by Prof. Ghigi, from Bologna, were used to make four more or less complete sets of 18 proportions, body angles, and counts. These were compared with my results for *H. clupeola*, as well as with those for *H. majorina*, the only species with which it might be confused. Despite the large size of the type (larger than any of my series), it

Fig. 14. American species of *Harengula*. Upper: *H. thrissina*, Stanford Coll. (mouth of Rio Mulege, Concepcion Bay, Gulf of California); lower: *H. clupeola* , Acad. Coll. (east coast of Panama). Alcohol. Natural size.

Fig. 15. Type specimens. Upper: *Harengula latulus* Cuvier and Valenciennes, a cotype (syntype), originally Paris M.N.H. no. 3236, now Stanford M.N.H. no. 32769 (?Dieppe). Lower: *Clupea macrophthalma* Ranzani, holotype, Ist. Zool., Bologna (?Brazil). In alcohol: Natural size.

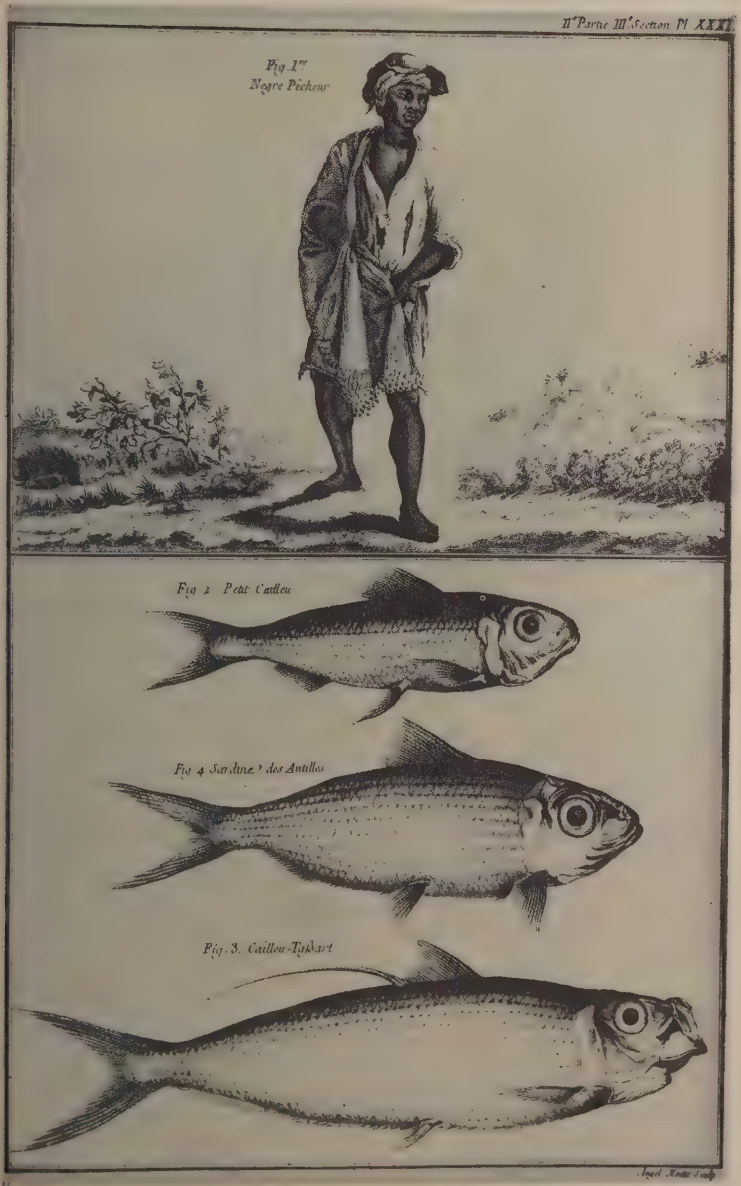


Fig. 16. Facsimile of plate 31, part 2, section 3 of Duhamel du Monceau's *raité Général des Pêsches*. Figures copied from sketches made in Guadeloupe by arbotteau. Fig. 2. *Harengula clupeola* (Cuvier). Fig. 4. *H. humeralis* (Cuvier). ig. 3. *Opisthonema oglinum* (Le Sueur). Original size of plate 326 x 209 mm.

Fig. 17. Three species of *Harengula* from one locality: St. Lucia, B.W.I. Top: *H. humeralis*; middle: *H. clupeola*; bottom: *H. majorina*. Stanford Coll. In alcohol. Natural size.

falls well within the limits for *H. clupeola* in all characters, and notably close to the mean in all except the head depth proportions (perhaps due to the great size of the type). The body angle measurements alone would serve to separate this fish from *H. majorina*.

Harengula latulus Cuvier and Valenciennes (*nec Clupea latulus* Cuvier 1829) 1847 p. 280 pl. 595 (my fig. 15) is *H. clupeola* (see discussion of genus). Types: Paris Museum (?Caen, ?Dieppe); a cotype, formerly Paris M.N.H. no. 3236, now Stanford N.H.M. no. 32769 (?Dieppe).

Harengula clupeola Cuvier and Valenciennes 1847 p. 289 (Martinique) is placed in the synonymy of *H. clupeola* (Cuvier) 1829, less on the basis of the 1847 description by Valenciennes, which is wholly inadequate, than on his citation of Duhamel's plate and description of "Petit Cailleu" (1776, pl. 31, fig. 2, and p. 546, Guadeloupe), which, as shown above, had already been cited by Cuvier as referring to his *Clupea clupeola*, though Valenciennes nowhere mentions this. Finally, the Cuvier and Valenciennes types in the Paris Museum could well be of this species, for Dr. Chabanaud reports these data: "*Harengula clupeola* CV. Longueur sans la nageoire caudale, 68 millimètres. Ecussons ventraux 18 + 12 sur un exemplaire, 19 + 12, sur un autre. Branchicténies du Ier. arc, 32. Nageoire dorsale sans tache noire; les derniers rayons nullement prolongés." Dr. Chabanaud also sent me a midlateral scale from one of the types, which shows crenulations at the free edge, ridges on the free surface radiating to it, with fenestrations between the ridges, and, most diagnostic of all, 2 continuous and parallel transverse grooves (*H. clupeola* has 2 - 3; *H. majorina* has 3 - 5).

Alosa bishopi Müller and Troschel 1848 p. 675 (Barbados) is placed, with a question, in the synonymy of *H. clupeola* chiefly for negative reasons, for in comparing it with their *Alosa apicalis* (see above) I find that they do not mention, for instance, any differences in the body shape, which should have aroused comment if they had had at hand specimens of the deep-bodied, short-headed *H. majorina*. I was unable to locate the type; it is probably in Berlin. The description follows:

> 80) Alosa Bishopi, *Müll. et Tr.* nov. sp. The sprat. D. 17; A. 17. This species agrees in some points with the former; it has, however, a black spot behind the operculum which is not to be observed in *A. apicalis*, and the dorsal fin is without the black mark. It possesses likewise, like *Alosa tyrannus* of DeKay (Zool. of N.Y., IV, p. 258, f. 13), the indistinct dark longitudinal lines; but the eye of the Barbados species is larger, its diameter being equal to half the height of the head. There are eleven rows of scales on each side of the body; the ventrals are fixed under the middle of the dorsal fin; the caudal fin is forked. Length four-and-half inches.

A word as to the fate of Poey's no. 377, species dubia. He first mentions it in 1861 (pp. 384, 395: "forte *H. clupeola* Val. *Sardina escamuda*. 377!"), and again in 1866 (p. 190); but on p. 378 decides it is not *H. clupeola*. In 1868 (p. 418) he again feels it might be Valenciennes' species, but finds the latter's description too incomplete. In 1876 (p. 147), he still questions its identity, but thinks it the same as Cuvier's 1829 *Clupea clupeola* (Poey is almost the only one to have read that footnote); however, he is still bothered by Valenciennes' description. Dr. Schultz writes: "Poey's original number 377, still in the jar, was entered in the catalog U.S.N.M. number 4795. There are two specimens: one,

100 mm. standard length (probably the total length was 140 mm.), is in fair condition; the other, 110 mm. standard length, has been dissected for vertebral count on one side. Caudal fins of both specimens are badly damaged. These fish are described by Poey in his *Synopsis Piscium Cubensium* 1868, vol. 2:418, but I do not think it constitutes a valid name." So it is still species dubia.

HARENGULA MAJORINA STORER 1868. The only account at all descriptive of this species is that of *H. humeralis* Cuvier and Valenciennes 1847 p. 298 (Guadeloupe, South America from Rio de Janeiro to the Antilles, Brazil, Bahia, Surinam, and "San Domingo"). Dr. Chabanaud examined the type of Cuvier and Valenciennes' description in Paris, and reports: "*Harengula humeralis* CV. Longueur sans la nageoire caudale, 85 millimètres. Roussons ventreux: 18 + 14. Branchicténies du 1er. arc (comptées suivent vos indications) 81. Nageoire dorsale sans tache noire; les derniers rayons nullement prolongés." He also sent me a scale from the midlateral section of this specimen. There are faint crenulations, ridges, and fenestrations, and 8 parallel and continuous grooves. Dr. Chabanaud expresses the belief that the Paris Museum specimens of *humeralis* and *clupeola* of Valenciennes are the same species, and the specimens doubtless do appear alike (as do all West Indian species of *Harengula*), particularly since both are well below the mean in standard length for either species. As pointed out earlier, small size profoundly affects the depth proportions, so that comparisons between small representatives of these species cannot always be made by eye alone. Only *H. majorina* would fit Valenciennes' description. The scute count of the Paris specimen proves that it cannot be *H. humeralis* (Cuvier). The number of transverse grooves in the lateral scale from this specimen is suggestive of *H. majorina*, and not at all of *H. clupeola*. These data all make me believe that the actual description of Cuvier and Valenciennes 1847 was probably based on examples of *H. majorina*, although without having personally examined the specimens, I cannot be certain. All of the localities cited by Valenciennes, save Santo Domingo, come within the range of *H. majorina*. The Santo Domingo specimens are separately mentioned by Valenciennes (p. 294) as "paraissent un peu plus allongés et un peu plus argentés." Very likely these were *H. clupeola*.

However, the name *humeralis* Cuvier and Valenciennes cannot be applied to my *majorina*. Valenciennes on p. 296 definitely says: "C'est d'après les documents fournis par Duhamel que M. Cuvier a désigné cette espèce dans une note du Règne animal, sous le nom de *Clupea humeralis*." It is perfectly evident, therefore, that the account of Cuvier and Valenciennes was merely an identification of their specimens with the fish which Cuvier had named *C. humeralis* in the *Règne Animal* (1829 edition, p. 318, footnote 2), and was in no sense a description of a new species. The fact that Valenciennes' identification was a mistaken one has no bearing on the fact. Cuvier's *C. humeralis* of 1829 was based wholly on Duhamel 1776 (pl. 31, fig. 4). Valenciennes (p. 294) states, following his description: "C'est, sans contredit, l'espèce représentée dans Duhamel sous le nom de *Sardine des Antilles*," with a footnote, as follows: "Duh., Traité des pêches, S. III, pl. 31, fig. 4, p. 548," but I have shown above that Duhamel's fish is the *humeralis* of the present study.

The holotype, Stanford N.H.M. no. 31742 (Santos, Brazil), is shown in figure 12, with a paratype, Calif. Acad. no. 10780. The other paratypes are: Stanford N.H.M. no. 32768, and Cal. Acad. nos. 5668, 5684, and 5685. (All are from the Province of São Paulo, Brazil.)

HARENGULA PENSACOLAE GOODE AND BEAN 1880. The original description, p. 182, is most unsatisfactory, but there is no doubt about the species. The two

types, U.S.N.M. no. 22831 (Pensacola), were examined for me by Dr. Schultz, who found gill-raker counts 35 - 37; ventral scutes 18 + 11 - 12 = 29 - 30. Authors have described *H. pensacolae*, or species with it in the synonymy (*H. arcuata* by Jordan, 1890, p. 645, Evermann and Kendall, 1894, p. 105; etc.), as ranging from the Gulf of Mexico to Brazil. I can find no trace of it south of the Gulf of Mexico, nor of *H. majorina*, the other deep-bodied species, north of St. Lucia.

Alausa striata Cuvier and Valenciennes 1847 p. 429 merited investigation because Jordan and Evermann (1896, p. 431) synonymize it with their *Sardinella humeralis* (Cuvier and Valenciennes), while Regan (1917b, p. 388) synonymizes it with *Harengula macrophthalma*. The very incomplete original description (Guadeloupe, Bahia) might possibly apply to *H. majorina*, though Valenciennes definitely excludes it from the genus because of the dentition, and later says it may be *Clupea arcuata* Jenyns 1842 p. 134 (Bahia Blanca, Argentina). Dr. Chabanaud examined the type for me in Paris, and reports: "*Harengula striata* (Bahia, provenant du Musée de Genève). Longueur sans la nageoire caudale 165 millimètres. Ecussons ventraux 20 + 15. Branchicténies du Ier. arc 39. Nageoire dorsale légèrement rembrunie; ses derniers rayons très allongés," and expresses the belief that it is not a *Harengula*. Examination of a lateral scale from the type, sent me by Dr. Chabanaud, indicates that it is not from any West Indian *Harengula;* the free edge is almost pointed, and is ragged; there are no traces of crenulations, ridges, or fenestrations; the single transverse groove is continuous, but very shallow and indefinite. These facts suggest that the type is not the specimen used by Valenciennes for his description (the Guadeloupe specimens have apparently disappeared), and that it is no *Harengula*.

Clupea arcuata has been shown by Norman (1937, p. 39) to be a true member of the temperate-water genus *Clupea*, and it ranges north only to the La Plata (Berg, 1895, p. 19). If the types of *Alosa striata* actually came from Guadeloupe and Bahia (Brazil), there is practically no chance that they could be *Clupea arcuata*. The definite placement of *Alosa striata* must await further data.

It is interesting to note that although Von Ihering (1930, p. 9) refers his Brazilian specimens to *Sardinella (Harengula) macrophthalma*, he complains of the state of the nomenclature, and includes in the synonymy only *S. humeralis* of Jordan and Evermann (1896, p. 431). This they describe as a deep-bodied fish with the ventral outline an even curve from chin to vent. Von Ihering's figure B, page 4, is of just such a "sardinha"; it looks like *Harengula majorina* and not at all like *H. clupeola*. In fact, except possibly for Ranzani's type *(Clupea macrophthalma)*, I have found no trace of *Harengula clupeola* in Brazilian waters.

HARENGULA PERUANA FOWLER AND BEAN 1924. The characters in the original description (p. 2) have been compared with those of my three examples of *H. thrissina*. The type, U.S.N.M. no. 83156 (Callao, Peru), was collected by the United States Exploring Expedition (1838-1842)[17], and is evidently in poor condition. If the description of *H. peruana* can be relied on, the fish cannot be *H. thrissina*. Only in the depth-in-length proportion, and possibly in the fin-ray counts are they comparable; the transverse scale counts, gill-raker and ventral scute counts, scale architecture, and all proportions given differ widely. *H. peruana*, from the description, could be a *Harengula*. But since the type is unique, and the locality data on many of the Exploring Expedition specimens still extant are known to be faulty, I cannot consider the fish further.

[17] Frequently referred to erroneously as the Wilkes Exploring Expedition.

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